

Journal of Hymenoptera Research

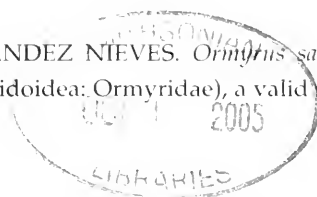
Volume 14, Number 2

October 2005

ISSN #1070-9428

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Journal. The *Journal of Hymenoptera Research* is published twice a year by the International Society of Hymenopterists, c/o Department of Entomology, Smithsonian Institution, Washington, D.C. 20560-0168, U.S.A. Members in good standing receive the *Journal*. Nonmember subscriptions are \$60.00 (U.S. currency) per year.

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Please see inside back cover of this issue for information regarding preparation of manuscripts.

Statement of Ownership

Title of Publication: Journal of Hymenoptera Research.

Frequency of Issue: Twice a year.

Location of Office of Publication, Business Office of Publisher and Owner: International Society of Hymenopterists, c/o Department of Entomology, Smithsonian Institution, 10th and Constitution NW, Washington, D.C. 20560-0168, U.S.A.

Editor: Gavin R. Broad, Centre for Ecology & Hydrology, Monks Wood, Abbots Ripton, Huntingdon, Peterborough PE28 2LS, UK.

Managing Editor and Known Bondholders or other Security Holders: none.

This issue was mailed 7 October 2005

Cladistic Assessment, Key and Description of Two New Neotropical Genera and Species of Gabuniina (Hymenoptera: Ichneumonidae: Cryptinae)

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Abstract.—The Cryptini *Fenixia* n. gen., from the Brazilian Atlantic Forest, and *Dineotropica* n. gen., from the Amazon basin, are proposed, described, and cladistically compared with literature data for representative species of all genera of the subtribe Gabuniina and 38 outgroup species. A total of 72 species and 51 characters are evaluated. Implied weighting results suggest that *Fenixia* is closely related to *Lagarosoma* Gupta, while *Dineotropica* is closest to *Cestrus* Townes. Unweighted analyses were inconclusive, but implied weighting results support the monophyly of Gabuniina essentially as defined in the literature, and suggest that *Wuda singularis*, and perhaps a few other taxa of Ceratocryptina, might be part of, or a sister taxon of that subtribe. The species *Fenixia curta* n. sp. and *Dineotropica lissa* n. sp. are described and illustrated. A key to genera of neotropical Gabuniina is presented.

The subtribe Gabuniina was proposed by Townes (1970) to include a worldwide group of cryptine wasps currently with 31 genera and 309 described species (Yu and Horstmann 1997). Members of this subtribe seem to attack xylophagous larvae of Coleoptera and Lepidoptera, exhibiting a highly specialized body structure for this purpose, as noted by Townes and Townes (1962): head subspherical; body shape approximately cylindric; ventral tooth of mandible normally longer than dorsal tooth; fore tibiae dilated, having enlarged subgenual organs; antennal tip highly modified; ovipositor compressed, straight and stout, the lower valve with an apical dorsal lobe that encloses most of the tip of upper valve; and subapical metasomal segments enlarged, accommodating special ovipositor muscles. The specialized antennal tip is used to tap the wood, producing pulses of sound (Townes and Townes 1962, Henaut 1990, Otten et al. 2000); the echoes are detected with the enlarged subgenual organs (Vilhelmsen et al. 2001, Otten et al. 2003), providing infor-

mation about the exact location of the host. Broad and Quicke (2000), discussing the adaptive significance of host location by vibrational sounding, further demonstrated that such tibial and antennal specializations are correlated with greater relative host depth, immobility of the host and idiobiosis.

Most gabuniines occur in the tropics and subtropics, but there are a few genera confined to the Nearctic region and some others which occur in the Palearctic region (Gupta and Gupta 1983). Seven genera have been described for the Neotropical region, but only two appear to be common, *Digonocryptus* Viereck, and *Agonocryptus* Cushman. The group has never been extensively studied in South America and the two new genera proposed herein point to a much greater diversity of the subtribe in this region.

Comparative studies with Cryptinae, however, are challenging, both because of their extreme diversity, nearing 380 valid genera and over 4500 valid species, and because many of these taxa are also exter-

nally similar, while exhibiting a confusing array of subtle differences, making them difficult to recognize at first sight, complicating generic and supergeneric classification in particular. In an attempt to objectively assess these problems, the present work uses cladistic analyses with the aim of testing the validity of, and situating the proposed genera into, the tribe Cryptini. A final objective is to present a first, while not thorough, cladistic assessment of the monophyletic status of the subtribe Gabuniina based on external morphology, furthering the molecular analyses of Laurence et al. (2003) with six gabuniine genera, most of them recovered as a monophyletic group.

MATERIALS AND METHODS

General.—This work deals exclusively with material acquired through an extensive program of field excursions and visits to entomology museums in Brazil, as part of a multi-institutional project developed along the years 2000–2004, now continued by the author in a new program. Specimens of neotropical countries unavailable in Brazilian museums were not examined for this work, but are targeted for study as part of the program in progress.

Morphological terminology follows Gauld et al. (1997); acronyms for collections follow Arnett et al. (1993). Drawings were prepared by Gláucia Marconato, under the author's supervision.

Selection of taxa and characters.—Cladistic analyses were performed exclusively for providing an objective evaluation of the proposed taxa, particularly in relation to published data. Accordingly, character selection and coding fit this aim only, and results were not explored for the internal phylogeny of Cryptini or Gabuniina.

Literature information was combined with original data, coded into a character matrix, and analysed with cladistic methods. The ingroup includes representatives of all described Gabuniina genera. A comparatively large number of outgroup taxa

(38 species) had to be considered, as a response to the following problems. First, there is a lack of clearly defined sister-groups for Gabuniina and, at the same time, the current subtribal arrangement for Cryptini is highly artificial; with this, outgroup taxa had to be selected from numerous species apparently or supposedly related to Gabuniina. Second, extensive tests with different taxa or groups of taxa, during preliminary analyses, showed that reasonably stable results could only be obtained with a large number of outgroup taxa.

The character set has a slight emphasis on features habitually used for describing genera of Gabuniina. Many characters were coded directly from illustrations, and checked with the corresponding descriptions whenever possible. The considered taxa are described and illustrated in Townes (1970), Gupta and Jonathan (1970), and Gupta and Gupta (1983). Characters 1–2, 4, 6–8, 18, 30, and 40–43 (Table 1) were coded from the general descriptions of Townes (1970) for the genera. For these characters, all species of a given genus were coded with the same character state. Although this may contribute, during tree search, to species in the same nominal genus to end up grouped in one clade, therefore supporting the original concept, this scheme was ultimately adopted because the potential problem is only marginally relevant for the purpose of this study. Character 7, the percentage of variation of the fore wing length, was calculated by taking the difference between the largest and the smallest wing length registered for the genus, and dividing it by the smallest wing length value. Two apparently distinct tendencies (Fig. 1) were interpreted and coded as two distinct character states. Regression lines for Fig. 1 were calculated with smoothing splines (Venables and Ripley 1997), which draw the curve that best suits a given data set.

Phylogenetic analysis.—Tree searching

was performed with heuristic analyses in NONA, version 2.0 (Goloboff 1993b) aided by Ratchet (Nixon 1999a), and with implied weighting in PIWE, version 2.8 (Goloboff 1997), which resolves character conflict in favor of characters that have less homoplasy *during* tree search. Cladogram analysis was performed with WinClada, version 1.00.08 (Nixon 1999b), which also incorporates the program Ratchet. All multistate characters were first treated as unordered, then characters 20, 32 and 33 were reinterpreted from the initial trees, and run as ordered. At this stage, changes for character 20 were interpreted as 0 \leftarrow 1 \rightarrow 2 and the character was respectively recoded in the matrix as 1 \leftarrow 0 \rightarrow 2, to allow the respective changes to be accurately considered during tree searching.

For Ratchet, independent searches were performed with a sample of 5–8 characters, and 3000 iterations on each run. The resulting trees were submitted at once to NONA, screened with *best* and *unique*, which discard non-optimal trees and trees that are optimization-sensitive, and then submitted to increasingly exhaustive searches, as follows: swapping with max*, a procedure which also certifies that the trees found will belong to a “complete island” (cited from PIWE manual), and further swapping with ms*1, and jump*1 to jump*4, which search for better trees in different “islands” by generating slightly less optimal trees from the ones found before. All steps found more or better trees, except jump*4.

For PIWE the options “hold 10000, mult*100” were used, with resulting trees submitted to further swapping exactly as described above for NONA. Searches were performed with the default value for *K*, the constant of concavity (Goloboff 1993a) and for *K* = 2 and *K* = 1. Higher values of *K* (4–6) were not tested because the intention was to check the maximum influence that less homoplasious characters could have on the phylogeny.

RESULTS

Table 1 shows the character list and character state coding, and Table 2 presents the respective character matrix. Searches with NONA/Ratchet found 6531 most parsimonious trees of 560 steps, Ci 14, Ri 54. The respective strict consensus tree is almost entirely collapsed and only marginally informative for Gabuniina. For this reason, it will not be considered here. With implied weighting, results are as follows: searches with *K* = 1 found 3071 trees of fit 110.4; *K* = 2 generated 3 trees of fit 141.9; and *K* = 3, the default value, yielded 29 trees of fit 172.9. Results with *K*1 are not illustrated because they were generally similar to those obtained with *K*2–3, except that the correspondent consensus tree was considerably less well resolved, with 34 collapsed nodes versus 1 and 11 collapsed nodes for *K*2 and *K*3 trees, respectively. All cladograms for each of these searches preserved clades of interest for Gabuniina as a whole (Figs. 2, 5), and for the proposed new genera (Figs. 3–4, 6–7).

All weighted searches recovered a clade with 30 Gabuniina genera, supported by a single, non-homoplasious character state (42:1, petiole spiracle approximately at middle). Relationships among the taxa within Gabuniina were also similar in these searches. *Fenixia* n. gen. appears in a collapsed clade on searches with *K*1, but is associated with *Lagarosoma* on all searches with *K*2–3 (Figs. 3, 6); *Dineotropica* n. gen., in its turn, was recovered forming a clade with *Cestrus* on all weighted searches, supported by at least two synapomorphies (33:0, hind wing vein M+Cu weakly convex, and 51:1, ovipositor subapically with a microsculptured area) (Figs. 4, 7).

Characters traditionally used to define Gabuniina (numbers 4, 42, 48 in Table 1) performed similarly in each analysis (Figs. 2, 5, arrows), generally showing comparatively high Ci and Ri values for the re-

Table 1. Character coding. Abbreviation: *n/a*, non-applicable.

No.	Description
01	Clypeal margin, number of median teeth 0 [0], 1 [1] or 2 [2], even if small
02	Mandible with ventral tooth longer than dorsal [0]; equal size [1]; ventral tooth shorter than dorsal [2]
03	Epomia short and weak [0]; long and strong [1]; represented by a group of wrinkles, rather than a single carina [2]; absent [3]
04	Fore tibia of female regular-looking [0]; swollen, basally constricted [1]
05	Sternaulus complete, reaching middle coxa [0]; incomplete, reaching 0.45–0.65 of the distance to middle coxa [1]; absent [2]
06	Pleural carina absent [0]; distinct and complete [1]; distinct but weak and incomplete [2]
07	Fore wing length variation up to 125% [0]; more than 125% [1]
08	Fore wing vein 1-Rs+M straight or slightly convex [0]; concave or sinuous, even if slightly [1]
09	Fore wing crossvein 1m-cu about as long as vein 1-Rs+M [0]; distinctly shorter [1]; distinctly longer [2]; <i>n/a</i> (limit between veins indistinct) [–]
10	Fore wing bulla on vein 1-Rs+M central [0]; apical, reaching cell 1+2Rs or nearly so [1]; bulla absent [2]
11	Fore wing crossvein 1m-cu straight or uniformly curved [0]; sinuous or somewhat irregular [1]
12	Fore wing without a short vein projection (ramellus) arising at meeting of veins 1m-cu and Rs+M [0]; a short projection present [1] (partially linked to character 14)
13	Fore wing limit between 1m-cu and 1-Rs+M distinct [0]; indistinct, veins perfectly continuous [1]
14	Fore wing vein 1M+Rs weakly and uniformly curved, or straight [0]; slightly sinuous or weakly irregular [1]
15	Fore wing crossvein 1cu-a usually far from base of 1M+Rs (basad by more than 0.1 its own length) [0]; veins very close (approximately basad by 0.1 or apicad) or opposite [1]
16	Fore wing crossvein 1cu-a at approximately 90° with M+Cu [0]; distinct obtuse angle [1]; distinct acute angle [2]
17	Fore wing vein 2-Cu distinctly longer than crossvein 2cu-a [0]; nearly of the same length or 2cu-a slightly longer [1]; 2cu-a much longer than 2-Cu [2]; 2-Cu entirely absent [3]
18	Fore wing vein 2-Cu and 2cu-a aligned [0]; angled, even if slightly [1]; <i>n/a</i> [–]
19	Fore wing vein 4-Rs uniformly curved [0]; sinuous or irregular [1]
20	Fore wing crossvein 2m-cu with bulla mostly central to mostly ventral [0]; placed entirely or mostly on anterior 0.5 [1]; nearly reaching or reaching cell 1+2Rs [2]. Recoded in the matrix as 1, 0, 2 respectively, and run as additive.
21	Fore wing cell 1+2Rs (areolet) size, even if open, small [0]; large, about as tall as width of pterostigma [1]; not differentiated [–]
22	Fore wing crossveins 2r-m and 3r-m parallel or nearly so [0]; distinctly but slightly or moderately convergent towards anterior margin of wing [1]; strongly convergent [2]; <i>n/a</i> (areolet open or not differentiated) [–]
23	Fore wing veins 2-M and 3-M approximately of the same length, or one slightly shorter than the other [0]; 3-M distinctly longer than 2-M [1]; 2-M distinctly longer than 3-M [2]; <i>n/a</i> [–]
24	Fore wing crossvein 3r-m tubular, normal [0]; entirely or partly nebulous or spectral, including “with bulla” [1]; not differentiated, cell 1+2Rs open [2]; <i>n/a</i> (cell 1+2Rs not developed) [–]
25	Fore wing cell 1+2Rs pentagonal, or nearly square or circular, even if slightly taller than wide or if open [0]; transversely elongate [1]
26	Fore wing vein 4-M slightly to distinctly longer than 4-Rs [0]; nearly as long as, or shorter, than 4-Rs [1]; 4-M nebulous or spectral on apical half or more [2]
27	Hind wing vein 2-1A short, not reaching wing margin, or absent [0]; ending near or at wing margin [1]
28	Hind wing vein 1-Cu with nearly the same length as crossvein cu-a [0]; 1-Cu distinctly longer [1]; 1-Cu distinctly shorter [2]
29	Hind wing vein 2-Rs entirely tubular [0]; apical half or more nebulous or spectral [1]
30	Hind wing crossvein 1r-m entirely tubular [0]; with one bulla [1]
31	Hind wing veins 1-Rs and 2-Rs forming a distinct angle (cell R1 somewhat trapezoidal basally) [0]; continuous or nearly so (cell R1 pointed or lanceolate basally) [1] [coded as multi-state when doubtful or intermediate]
	Fore wing veins 1-Cu and M at about 90° [0]; forming a distinctly acute angle [1]; forming a distinctly obtuse angle [2]

Table 1. Continued.

No.	Description
33	Hind wing vein M+Cu uniformly and weakly convex, or straight [0]; strongly convex [1]; concave [2]
34	Hind wing vein 1-R1 (the short section of R1 detached from wing margin) distinct [0]; not differentiated [1]
35	Anterior transverse carina of propodeum straight or weakly and uniformly curved [0]; strongly curved, trapezoidal or acuminate medially [1]; fused with posterior transverse carina [2]; absent [3]
36	Posterior transverse carina of propodeum present, even if interrupted centrally or indicated only by lateral crest or spines [0]; entirely absent [1]
37	Posterior transverse carina of propodeum uniformly convex, weakly or strongly, even if briefly interrupted centrally [0]; strongly bell-shaped or trapezoidal [1]; forming lateral crests [2]; forming lateral tubercles or spines [3]; n/a (absent) [-].
38	First metasomal tergite short and triangular, length/(maximum width – minimum width) less than 4.0 [0]; regular, somewhat elongate $lg/(w_{max} - w_{min})$ 4.0–6.0 [1]; long and slender, $lg/(w_{max} - w_{min})$ over 6.0 [2]
39	First metasomal tergite without a basolateral triangular tooth [0]; tooth present, even if vestigial [1]
40	First metasomal tergite without an <i>extra</i> basolateral triangular tooth [0]; extra tooth present [1]
41	First metasomal tergite without dorsolateral carina [0]; partially developed [1]; complete [2]
42	Spiracle of first metasomal tergite placed beyond middle [0]; at or basad of middle [1]
43	T7-8 in lateral view of similar size or shorter than T5-6 [0]; distinctly wider [1]
44	Upper valve of ovipositor in lateral view distinctly widest preapically, the nodus tall, giving triangular aspect to apex [0]; width decreasing uniformly, nodus weak or not evident, apex not triangular [1]
45	Upper valve of ovipositor apically straight or nearly so [0]; distinctly downcurved [1]; distinctly upcurved [2]
46	Upper valve of ovipositor apically without serrations [0]; serrations present [1]
47	Upper valve with preapical notch [0]; absent [1]; modified structure [2]
48	Lower valve of ovipositor apically regular, not dilated [0]; dilated and overlapping upper valve as a lobe [1]; apically widened to cover entire tip as a sheath [2]
49	Lower valve of ovipositor with serrations along entire tip [0]; restricted to the very tip, or serrations absent [1]
50	Ovipositor tip with upper valve apex blunt or only moderately pointed [0]; ending in a long and narrow point [1]
51	Ovipositor just basad of apical teeth smooth and polished [0]; with a distinctly microsculptured area [1]

spective trees, as follows. Character 4 (swollen fore tibia of female) with Ci 12–14 and Ri 78–81; character 42 (T1 with spiracle at or behind middle) with Ci and Ri = 100 in all implied weighting cladograms; and character 48 (lower valve with lobe enclosing upper valve) with Ci 33 and Ri 87 also in all cladograms.

DISCUSSION

Preferred cladograms.—The ambiguous results obtained with K1 searches point to a negative consequence of the maximized weight given to a few, less homoplasious characters in the matrix. This clearly de-

preciated most of the already weakly informative characters, to a point where K1 searches could have mimicked unweighted searches, which were mostly uninformative. Cladograms obtained with K2–3 seem therefore to represent the best possible results with the available information in the character set of Table 2, and because of this are adopted as the preferred phylogenetic interpretation.

Gabuniina.—In spite of a few differences at the base of the respective clade, the weighted analyses generally corroborate the idea that the Gabuniina of authors might be a monophyletic group. They also

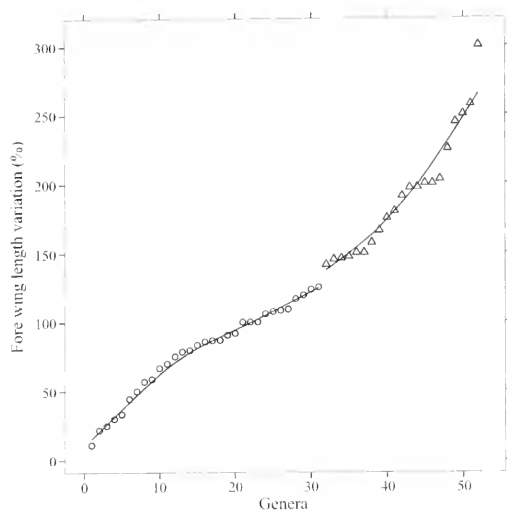


Fig. 1. Plotted data for character 7 (Table 1), with regression lines showing two distinct tendencies (concave vs. convex lines) for the known percentage of variation of the fore wing length, for the genera listed in Table 2.

generally confirmed the relevance of characters traditionally used in the literature (numbers 4, 42, and 48, Table 1) to define and characterize the subtribe, lending support to Gabuniina plus a few basal taxa (particularly Ceratocryptina), or to Gabuniina minus a few of its basal taxa. The marked phylogenetic importance of these characters is also suggested by their comparatively high values of Ci and Ri.

The repeated presence of *W. singularis*, and other Ceratocryptina as well, at the base of the Gabuniina clade suggests that this group, or possibly the genus *Wuda* as a whole, may represent a basal member of Gabuniina, or its sister taxa. The implied weighting results also support the suggestion of Gupta and Gupta (1983) that the genera of Gabuniina "appear to form two distinct groups" based on the presence/absence of the pleural carina (ch. 6, Table 1). This character showed high values of Ci (66–100) and Ri (91–100) on all cladograms, suggesting that Gabuniina with a pleural carina may represent a monophyletic group. Gupta and Gupta (1983) also suggested similar groups based on the

number of clypeal teeth (ch. 2), and on the comparative length of hind wing vein 1-Cu and crossvein cu-a (ch. 28), but this is not supported by the current analyses, with very low Ci and Ri values for both these characters.

Relationships of Fenixia and Dineotropica.—Results clearly indicate that these taxa must be assigned to Gabuniina, as defined in the literature and as recovered here. *Fenixia* n. gen. and *Dineotropica* n. gen. also appear to be only distantly related to one another, each being recovered within its own large and distinct clade, and therefore isolated from each other by numerous steps. At the same time, *Fenixia* seems most closely related to *Lagarosoma* Gupta, the two forming a clade supported by an identical set of synapomorphies (Figs. 3, 6). Such relationship is further corroborated by the fact that both these genera are known exclusively from south-eastern Brazil.

The close relationship of the central Amazonian *Dineotropica* with the essentially Mexican *Cestrus* seems evident by the sharing of a unique feature within Gabuniina, the ovipositor apex with a microsculptured area just basad of apical teeth (ch. 51:1), as well as the hind wing with a weakly convex vein M+Cu (ch. 33:0), and the propodeum with posterior transverse carina strong, complete. Nonetheless, the uniqueness of *Dineotropica* is evident by at least 9 apomorphies, repeatedly recovered for this genus in all K1–3 cladograms (Figs. 4, 7).

DESCRIPTIONS OF NEW TAXA

Fenixia Aguiar, n. gen.

Figs. 8–12

Type species.—*Fenixia curta* Aguiar, by monotypy and present designation.

Description.—Fore wing 6.3–10.7 mm long. Frons finely granulose, with a short median carina developed near anterior ocellus only. Clypeus weakly convex, more projected ventrally, the apex trun-

cate and with a median tooth. Mandible 1.5 as long as basal width, dorsal tooth as long as ventral tooth. Occipital carina meeting hypostomal carina. Epomia short and weak. Sternaulus sharp and reaching middle coxa. Epicnemial carina distinct along entire height of mesopleurum. Hind margin of metanotum without projections on each side of postscutellum. Area between metanotum and propodeum moderately deep, narrow, forming a polished smooth trough. Propodeum as long as wide. Propodeal spiracle oval elongate. Pleural carina absent. Propodeum in front of basal carina punctate and allutaceous; behind basal carina transversely rugulose to rugose. Juxtacoxal carina absent. Apical carina of propodeum indistinct, or indicated by weak lateral crests.

Fore wing cell 1+2Rs about as long as width of pterostigma, a little higher than wide, cross veins 2r-m and 3r-m distinctly convergent, about same length. Ramellus absent. Crossvein 1cu-a slightly but distinctly basad of vein 1M+Rs. Hind wing vein 1-Cu 1.9 length of crossvein cu-a; 2-1A reaching 0.5–0.8 the distance to wing margin. Fore tibia in female moderately swollen. Fourth segment of all tarsi deeply bilobed. First metasomal tegite with a distinct lateral triangular tooth at the base; dorsolateral carina absent; spiracle exactly at middle; sternite about 0.43 the length of tergite. Ovipositor 1.2 as long as hind tibia, projecting beyond metasoma for half of its own length; ovipositor sheath about 0.65 as long as hind tibia. Lower valve of ovipositor with a weak to distinct subapical lobe that partly encloses upper valve; apex with 8 teeth.

Etymology.—A reference to the city of Fênix (Paraná, Brazil), the collecting locality for one of the paratypes.

Comments.—The genus runs to *Dagathia* Cameron in the key provided by Townes (1970) for the world genera of Gabuniina, but can be isolated from this Oriental genus by having mandible teeth of equal size (vs. ventral tooth a little longer),

epomia small (vs. long and strong), fore wing vein 4-Rs sinuous (vs. straight), cell 1+2Rs large and pentagonal, 2r-m and 3r-m convergent, 2-1A not reaching wing margin, and ovipositor sheath very short, 0.7 as long as hind tibia (vs. 1.1 as long). According to the cladistic analyses, *Fenixia* also seems related to the sympatric genus *Lagarosoma* Gupta, from which it can be isolated by the clypeus margin with one tooth (absent in *Lagarosoma*), fore wing 2-Cu distinctly longer than 2cu-a (vs. much shorter), crossvein 1cu-a very close or opposite 1M+Rs (vs. far from base), cell 1+2Rs higher than wide (vs. wider than high), 2r-s and 3r-s about same length (vs. 3r-s distinctly longer), and basal carina of propodeum strong and distinct (vs. indistinct or absent). Other distinctive character states are indicated on the respective cladogram (Figs. 2, 5) and key to neotropical genera, below.

Fenixia curta Aguiar, n. sp.

Figs. 8–12

Description.—Female (holotype). Fore wing 10.7 mm long. Clypeus weakly convex, more projected ventrally, the apex truncate and with a median tooth. Mandible teeth of equal length. Occipital carina low and sharp throughout, joining the weakly raised hypostomal carina below. Pronotum: epomia weak, sharp, and short, distinct only in between dorsal and ventral yellow marks; area behind epomia, in between yellow stripes, with longitudinal rugulosity. Mesonotum: notauli deep, converging posteriorly, blending with longitudinal rugulosity on and behind central yellow spot; notauli and rugulosity ending far from scuto-scutellar groove. Scutellum micropunctate. Mesepisternum finely obliquely strigate, stronger dorsally; epicnemial carina entirely distinct; sternaulus strongly sinuous, distinct from epicnemial carina to base of hind coxa; without any indication of a depression between sternaulus and speculum. Metapleuron densely rugulose. Propodeum

Table 2. Continued.

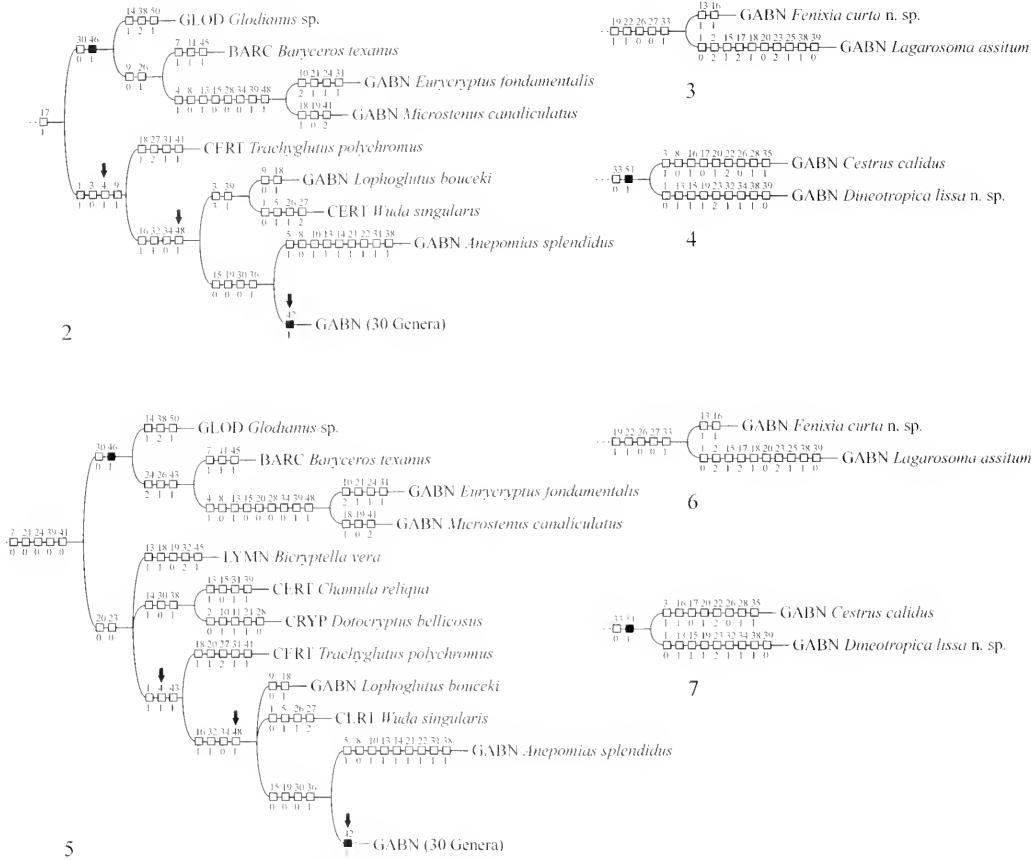
Subt.	Species	1	10	20	30	40	50
Cryp	Trachysphyrus cleonis	01?00?1021	1001100012	1201001a01	a020101000	1000000000	0
Cryp	Trachysphyrus cyanipennis	01?00?1022	1100110012	1000001a01	a100103000	1001101000	0
Cryp	Trachysphyrus lachnaels	01?00?10-0	0011100012	1201011a01	0001103000	1000000000	0
Cryp	Trachysphyrus tucman	01?00?1001	1100100012	1011000a01	a000100000	1000200001	0
Cryp	Xylophrurus dispar	10?10?0000	0100100111	1201001001	00a1000000	2001000100	0
Glod	Glodianus sp.	0?100?0120	0001101011	0020001100	0011001200	0001011001	0
Gory	Buodias longidentatus	?1a00?0021	0000101112	1001001101	00a0003110	2000000000	0
Gory	Buodias ruficoxis	?1a00?1100	0000111111	1021111101	a0a0102110	2001001000	0
Gory	Biodias sp.	?1a00?1020	10?0101111	1021001100	12a001-110	2000000001	0
Gory	Goryphus basilaris	a1100?1000	0000100111	10010?1101	a010002010	2000000000	0
Gory	Goryphus communis	a1100?1100	0000101111	0001001101	a01a002010	2000000000	0
Gory	Listrognathus pubescens	?1101?1120	0000000011	1021001101	001a101010	2001002000	0
Gory	Necolio imperialis	01d01?1100	0001110111	1021001101	a0a0102110	a000000011	0
Gory	Necolio sp.	01d01?1100	0001100111	1020001100	10a1001110	a001000010	0
Lymn	Bicryptella vera	0b100?00-0	0010100100	0000001101	a21a100000	?001101000	0
Lymn	Lyneon orbis	2b?10?1100	1000102100	1-02000101	1211002000	0000000000	0
Lymn	Pachysomoides fulvus	0b100?0100	0000110010	0-02001101	0210101000	2000000011	0
Lymn	Polycyrtidea flavopicta	0b101?0010	0001103-10	0-02002-11	1011000200	0000000001	0
Meln	Melanocryptus sp. A	12001?1100	0000100110	1101001101	0000103100	101a001000	0
Meln	Melanocryptus sp. B	12001?1100	0001111111	1111001101	a010002100	1010001000	0
Mest	Mesostenus transfuga	01100?1100	0010a00011	0-221c1110	0000100110	?001000010	0
Ospr	Osprynchotus gigas	00110?0110	0101121011	1211011200	000011-2?0	?001000200	0

* Corrected spelling for *Agrothereutes abbreviator* according to Horstmann (2001).

scarcely pilose; anteriorly shallowly punctate near anterior transverse carina, the punctures becoming progressively more scarce towards axillary trough; this area also distinctly and densely alutaceous; area posterior to transverse carina transversely rugose; spiracle weakly oval, almost circular; anterior transverse carina low, straight, except weakly arched centrally; propodeal apodeme represented by low carina on center of lateral yellow spot; pleural carina indistinct. Legs: all preapical tarsomeres deeply bilobed. Metasoma: T1 dorso-lateral carina distinct only from spiracle to apical margin; T1-4 very finely microsculptured, much stronger and matt on T2; then gradually changing from alutaceous on T5 to almost polished smooth on T8; T8 weakly to strongly convexly folded centro-longitudinally. Ovipositor sheath dilated and spoon-shaped on its apical 0.3; lower valve of ovipositor with 8 apical teeth; upper valve with tiny sub-

apical notch. Wing venation as described for the genus.

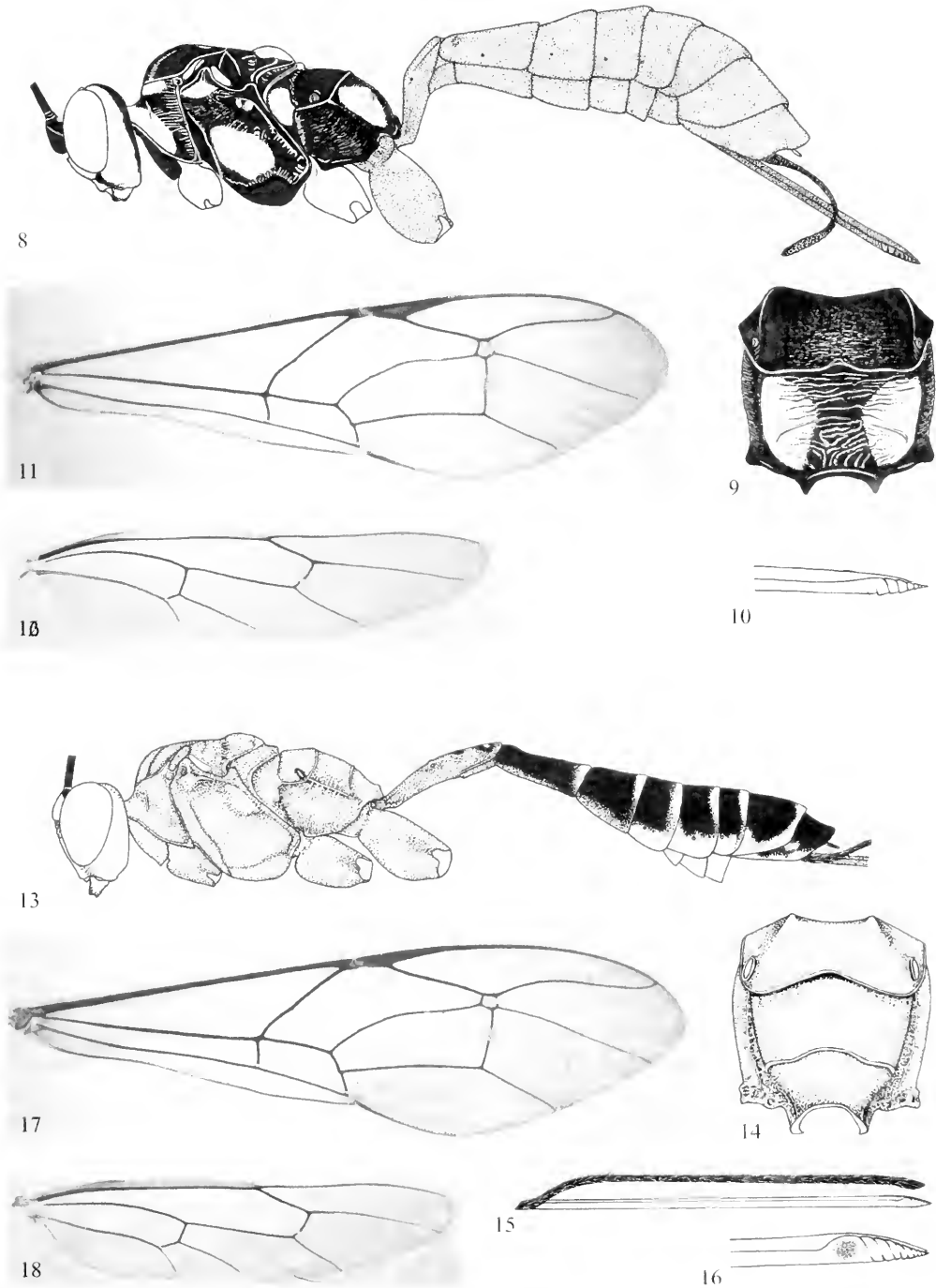
Color.—Head and mesosoma black with yellow marks; metasoma reddish. Head: scape, pedicel, flagellomeres 1-3, and basal 0.8 of 4th, black; apex of 4th, 5-8 entirely, and most of 9th, yellow; 10-13 dark brown, 14 to apical entirely brown; 28 flagellomeres total on both antennae, the apical one moderately compressed and protruded at apex. Orbital band yellow, complete except very briefly interrupted at bottom of eye; taking entire width of gena ventrally, gradually narrowing dorsally to as narrow as 0.4 the distance between eye margin and occipital carina at temple; width at frons and face about 0.25 interocular distance; face mostly yellow, partly fusing with yellow of orbital band; clypeus yellow, with wide black area isolating it from yellow of face and orbital band; also yellow on labrum, large spot taking basal 0.4 of mandible, and labial and max-



Figs. 2-7. Summary of clades containing the Gabuniina of authors, and clades containing the genera *Fenixia* and *Dineotropica*, preserved on trees obtained with implied weighting searches. 2, Clades from the strict consensus of 3 trees obtained with searches for $K = 2$. 3, Same, for section of tree containing *Fenixia*. 4, Same, for *Dineotropica*. 5, Clades from the strict consensus of 29 trees obtained with searches for $K = 3$ (default value). 6, Same, for section of tree containing *Fenixia*. 7, Same, for *Dineotropica*. The arrows indicate characters traditionally used to define the subtribe Gabuniina. Subtribe abbreviations: BARC, Baryceratina; CERT, Ceratocryptina; GABN, Gabuniina; GLOD, Glodianina; LYMN, Lymeonina.

illary palpi, except for brown apical article. Mesosoma black, except yellow as follow: broad band on pronotum along anterior and ventral margins, ending distinctly before reaching posterior corner, barely interrupted centro-anteriorly, and a moderately wide band on central 0.7 of dorso-lateral margin; diffused marks on prosternum basally; large hexagonal spot taking about 30% of mesopleuron; all sub-
m and tegula; small spot dorsally on
central subcircular spot on me-
between area of convergence
and post-scutellum

entirely; axillary trough except small area mesally; large subtriangular spot on each side of propodeum, behind posterior transverse carina, each one about 0.3 as wide as propodeal width. Legs: fore and mid coxae, except mesally, pale yellow, large spot dorso-basally, at level of dorsal articulation of hind coxa, yellow; hind coxa, trochanter and femur red-brown; fore and mid trochanters, femora, and basitarsomere yellowish brown, with blackish centrally; all tibiae and tarsomeres 1-4 of hind leg golden yellow; tarsomeres 3-5 of fore and mid legs, and apical tarsomere of



Figs. 8–18. *Fenixia curta* n. sp. Holotype ♀: 8, Habitus, left. 9, Propodeum, dorsal. 10, Tip of ovipositor, left. Paratype ♀: 11, Right fore wing. 12, Right hind wing, same paratype. Figs. 13–18. *Dineotropica lissa* n. sp. Holotype ♀. 13, Habitus, left. 14, Propodeum, dorsal. 15, Ovipositor and sheath, left. 16, Tip of ovipositor, left. 17, Right fore wing. 18, Right hind wing. Drawings by Gláucia Marconato.

hind leg, dark brown. Metasoma dark red, basal segments darker than apical segments; corners of T1 yellowish. Ovipositor dark red; sheaths dark brown. Wings hyaline.

Male.—General morphology and color similar to female, except for yellow tones clear and bright; orbital band not interrupted; face and clypeus entirely yellow; speculum entirely yellow; T1 apical margin with distinct yellow stripe. Male from Água Funda with yellow marks also on mesosternum, near base of coxa and along sternaulus.

Material.—15 ♀♀, 2 ♂♂. Holotype ♀ DZUP "N. Teutônia-S.C., Brasil-XI/1967, F. Plaumann leg." Paratypes: DZUP: ♀♀, "N. Teutônia, SC, Brasil-XI/1967, F. Plaumann leg."; "P. Grossa (Vila Velha), PR, Reserva IAPAR, BR 376, Brasil, 15.IX.1986, Lev. Ent. PROFAUPAR, Malaise" (3 specimens); same, 06.X.1986; same, 11.VIII.1986; "Jundiá do Sul, PR, Fazenda Monte Verde, Brasil, 24.XI.1986, Lev. Ent. PROFAUPAR, Malaise" (2 specimens); same, 15.XII.1986; "São José dos Pinhais, PR, Serra do Mar, BR 277, Km 54, Brasil, 16.III.1987, Lev. Ent. PROFAUPAR, Malaise"; "Curitiba, PR, CI, 28.XII.1976–10.I.1977, V. Graf leg."; "Curitiba, PR, Brasil, 09.XI.1978, F. Giacomel leg."; "Colombo, PR, EMBRAPA, BR 475, Km 20, Brasil, 22.IX.1986, Lev. Ent. PROFAUPAR, Malaise"; ♂, "Fênix, PR, 03.X.1986, A. F. Kumagai col."; ♀, "Blumenau, SC, Brasil, V. Graf leg.". MZUP: ♂, "São Paulo, Água Funda, SP, 21.VIII.1967, Curso D.Z."

Variability.—General morphology: rugosity laterally on pronotum sometimes very weak; propodeal apodeme sometimes entirely absent, not even indicated as a low carina; metapleuron sometimes densely pilose. Color: Yellow may change to pale yellow or almost white in small specimens; extension of yellow on face and clypeus highly variable, from entirely and continuously yellow in female from Monte Verde (15.XII) to widely black in between these areas, forming an "M" or "H" figure, as in female from Blumenau. Prosternum entirely black to mostly yellow; yellow on speculum varying from small spot dorsally to yellow on its 0.8 lateral stripe and size of yellow area on face and clypeus highly variable, taking up to 1/2 of face area. On smallest female

examined (from Monte Verde, 24.XI), black replaced by dark brown, and hind coxa without yellow spot. Female from São José dos Pinhais with ovipositor sheath yellow on inner surface.

Etymology.—From the Latin *curtus*, meaning short; in reference to the length of the ovipositor sheath.

Distribution records.—Southern and southeastern Brazil (SC, PR, SP).

Dineotropica Aguiar, n. gen.

Figs. 13–18

Type species.—*Dineotropica lissa* Aguiar, by monotypy and present designation.

Description.—Fore wing 16.1 mm long. Frons smooth, with a short median carina developed centrally only. Face with a strong U-shaped fold from one antennal foramen to the other. Clypeus flat, apical 0.3 truncate, apical margin uniformly blade-like, translucent, without a median tooth. Mandible 1.67 as long as basal width, ventral tooth distinctly longer than dorsal tooth. Occipital carina meeting hypostomal carina. Epomia short and weak. Sternaulus sharp and reaching middle coxa. Epicnemial carina curving posteriorly and ending near subalarum. Hind margin of metanotum regular, but front margin of propodeum with strong tooth-like projections towards each side of postscutellum. Area between metanotum and propodeum moderately deep, wide in between tooth-like projections, narrow laterad of it, forming a polished smooth trough. Propodeum about 1.25 as long as wide. Propodeal spiracle large, elongate. Pleural carina strong, with cross ridges along its length. Propodeum entirely polished smooth; both anterior and posterior transverse carinae conspicuous and complete; the anterior carina regular and somewhat acuminate, the posterior carina more projected centrally, laterally expanded into a somewhat translucent crest. Juxta-coxal carina strong but small.

Fore wing cell 1+2Rs about as long as width of pterostigma, about 1.15 wider

than higher, crossveins 2r-m and 3r-m approximately parallel, about same length. Ramellus absent. Crossvein 1cu-a distinctly but shortly basad of 1M+Rs. Hind wing vein 1-Cu 1.3 length of crossvein cu-a; vein 2-1A ending very near wing margin. Fore tibia in female distinctly swollen. Fourth segment of all tarsi moderately to deeply bilobed. First metasomal tergite at base with a lateral flange, without a triangular tooth; dorsolateral carina absent; ventro-lateral carina present, more distinct apically, beyond spiracle; spiracle at basal 0.47, strongly protuberant; sternite about 0.61 the length of tergite. Ovipositor 1.74 as long as hind tibia, projecting beyond metasoma for 5 times its own length; ovipositor sheath about 1.44 as long as hind tibia. Lower valve of ovipositor with a distinct subapical lobe that encloses most of upper valve; apex with 9 teeth.

Etymology.—From the Greek *dynos*, meaning large, in reference to the body size, and informal reference to the Neotropical region, where the species was collected.

Comments.—The genus runs to *Cestrus* Townes in the key provided by Townes (1970) for the world genera of Gabuniina, but can be isolated from it by having a very short epomia (vs. long), propodeum fully smooth in front and behind both transverse carinae (vs. rugulose in between carinae), petiole elongate, almost straight in lateral view (vs. short and distinctly bent centrally), petiolar spiracle in lateral view fully dorsal (vs. centered), fore wing vein 2-Cu nearly of the same length of crossvein 2cu-a (vs. distinctly longer), areolet subquadrate, crossveins 2r-m and 3r-m nearly parallel (vs. distinctly pentagonal, 2r-m and 3r-m strongly convergent anteriorly), vein 2-M much longer than 3-M (vs. nearly of same length), and clypeus margin without a tooth (vs. usually with a tooth).

***Dineotropica lissa* Aguiar, n. sp.**

Figs. 13–18

Description.—Female (Holotype). Fore wing 16.1 mm long. Clypeus and Mandi-

ble as for the genus description. Occipital carina low and sharp throughout, joining the weakly raised hypostomal carina. Pronotum entirely polished smooth; epomia strong, sharp, short, transverse. Mesonotum: notauli anteriorly distinct, on posterior half weakly convergent and fused to dense longitudinal rugulosities, which end at scuto-scutellar groove; mesonotum otherwise weakly alutaceous. Scutellum with micropunctures derived from weak pilosity. Mesepisternum polished smooth; epinemial carina ending near, but not at, subalarum; sternaulus strongly sinuous, sharp and narrow from epinemial carina to base of hind coxa; without any indication of a depression between sternaulus and speculum. Metapleuron mostly polished smooth, with weak transverse rugulosities on its posterior 0.25. Propodeum mostly polished smooth, scarcely pilose; spiracle large and elongate; anterior and posterior transverse carinae strong and complete; anterior carina crossing shaft between propodeum and metanotum, ending on carinal triangle; posterior carina laterally somewhat raised, forming a crest, ending on pleural carina, which is strong, complete. Legs: all preapical tarsomeres deeply bilobed. Metasoma: first metasomal tergite, spiracle and sternite as in the genus description; T1 with a few punctures centrally, otherwise polished smooth; T2 with weak oblique creases; T3–8 polished smooth, densely covered by short golden pilosity. Ovipositor valves and sheath as in the genus description. Wing venation as described for the genus.

Color.—Head: scape yellow; pedicel, flagellomeres 1–2, and basal 0.9 of 3rd, black; apex of 3rd, 4–10 entirely, and most of 11th, yellow; 12th to apical entirely dark brown; 22 flagellomeres total, the apical one moderately compressed and protruded at apex. Orbital band yellow, complete except very briefly interrupted at bottom of eye; taking entire width of gena; narrowing dorsally to as narrow as 0.4 the dis-

tance between eye margin and occipital carina at temple; face, clypeus, and labrum entirely yellow; labial and maxillary palpi brownish; mandible basally orange, its teeth black. Mesosoma, including propodeum, reddish brown, darker dorsally. Legs reddish brown except yellowish to yellow fore to hind tibiae; tarsi darker from base to apex. Metasoma black; T1 dark red on basal 0.7, black apically, with yellow spot on central 0.5 of apical margin; T2–6 black, with yellow stripe on apical and lateral margins, apical stripe interrupted laterally, not fused to lateral stripe; T7 black, with yellow stripe on apical and

lateral margins, fused and continuous; T8 black with yellow stripe on ventral margin only. Ovipositor dark reddish brown; sheaths dark brown. Wings with brownish tint.

Male.—Unknown.

Material.—Holotype ♀ DZUP "Ouro Preto, d'Oeste, RO, [12-1?]-1987, C. Elias, leg"; "Projeto Polonoroeste."

Etymology.—From the Latin *lissos*, meaning polished, smooth; in reference to the body sculpture.

Distribution record.—Northwestern Brazil (RO).

KEY TO GENERA OF NEOTROPICAL GABUNIINA

- 1(0). Pleural carina present, even if incomplete 2
 - Pleural carina absent 5
- 2(1). Hind wing vein 1-Cu distinctly longer than crossvein cu-a; clypeal margin centrally normally with one or two small teeth 3
 - Hind wing vein 1-Cu nearly the same length or distinctly shorter than crossvein cu-a; clypeal margin centrally without a small tooth 4
- 3(2). Ovipositor just basad of apical teeth smooth; fore wing crossveins 2r-m and 3r-m more or less parallel; fore wing vein 2-Cu nearly as long as, or shorter than crossvein 2cu-a; hind wing vein M+Cu strongly convex *Digonocryptus* Viereck
 - Ovipositor just basad of apical teeth with a distinctly microsculptured area; fore wing crossveins 2r-m and 3r-m distinctly convergent toward anterior margin of wing; fore wing vein 2-Cu distinctly longer than crossvein 2cu-a; hind wing vein M+Cu weakly convex *Cestrus* Townes
- 4(2). Posterior transverse carina of propodeum complete, strong; ovipositor just basad of apical teeth with distinctly microsculptured area; fore wing crossvein 1cu-a very narrowly basad of 1M+Rs; fore wing vein 2-M much longer than vein 3-M; fore wing vein 2Cu slightly longer than crossvein 2cu-a *Dineotropica* n. gen.
 - Posterior transverse carina of propodeum absent; ovipositor just basad of apical teeth smooth; fore wing crossvein 1cu-a basad of 1M+Rs by 0.3 its own length; fore wing vein 2-M distinctly shorter than vein 3-M; fore wing vein 2Cu much shorter than crossvein 2cu-a *Prosthoporus* Porter
- 5(1). Clypeal margin centrally without a small tooth; first metasomal tergite somewhat elongate, maximum length/(maximum width—minimum width) about 4.2 6
 - Clypeal margin centrally with one or two small teeth; first metasomal tergite relatively short and triangular, maximum length/(maximum width—minimum width) about 2.5–3.0 7
- 6(5). Propodeum polished, unsculptured, entirely devoided of carinae; hind wing vein 1-Cu somewhat shorter than crossvein cu-a; fore wing crossvein 1cu-a basad of 1M+Rs by 0.36 its length; fore wing vein 2-Cu with about same length as crossvein 2cu-a; fore wing vein 2-M approximately as long as vein 3-M *Trypha* Townes
 - Propodeum granulate to granulate-striate, the anterior transverse carina complete, al-

- most straight; hind wing vein 1-Cu distinctly longer than crossvein cu-a; fore wing crossvein 1cu-a narrowly basad or opposite vein 1M+Rs; fore wing vein 2-Cu greatly shortened, so that 3-Cu almost meets 1-Cu; fore wing vein 2-M distinctly longer than vein 3-M *Lagarosoma* Gupta et Gupta
- 7(5). Fore wing cell 1+2Rs small, 0.2–0.3 as high as length of vein 2m-cu; fore wing vein 1-Rs+M with bulla placed centrally; fore wing hyaline or infusate but never with dark bands 8
- Fore wing cell 1+2Rs very large, 0.50–0.95 as high as length of vein 2m-cu; fore wing vein 1-Rs+M with bulla apical, reaching cell 1+2Rs; fore wing hyaline, with three dark bands *Nesolinoceras* Ashmead
- 8(7). Fore wing crossveins 2r-m and 3r-m parallel or nearly so; hind wing vein 1-Cu with nearly the same length or slightly shorter than crossvein cu-a; fore wing vein 2-M substantially longer than vein 3-M *Agonocryptus* Cushman
- Fore wing crossveins 2r-m and 3r-m distinctly convergent towards anterior margin of wing; hind wing vein 1-Cu about twice as long as crossvein cu-a; fore wing vein 2-M approximately as long as vein 3-M *Fenixia* n. gen.

ACKNOWLEDGEMENTS

David B. Wahl contributed with valuable sugges- tions, guidance, and ideas to this work. Ian D. Gauld and Andrew Bennett also contributed on an earlier stage of the manuscript. Gavin R. Broad, Ilari E. Sääksjärvi, Donald L. J. Quicke and an anonymous reviewer read the submitted manuscript and re- turned very useful suggestions, corrections and in- formation. Vinalto Graf and Gabriel A. R. Melo loaned the specimens, after allowing the author to search the entire DZUP collection for unsorted Ga- buniina. Elisa Queiroz Garcia provided shelter and good company during the author's stay at DZUP. Lu- ciana Musetti, David Wahl, Santosh Gupta and An- drew Bennett helped with the literature. Rogério Rosa da Silva kindly calculated the graph for Fig. 1. Fund- ing for this project was provided by FAPESP (Brazil), paid directly to the author (Processes 00/05704-6 and 03/08585-6), or acquired from specific funds allocated to this work in a connected project of C. Roberto F. Brandão (FAPESP process 98/05083-0).

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 - Ovipositor just basad of apical teeth with a distinctly microsculptured area; fore wing crossveins 2r-m and 3r-m distinctly convergent toward anterior margin of wing; fore wing vein 2-Cu distinctly longer than crossvein 2cu-a; hind wing vein M+Cu weakly convex *Cestrus* Townes
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 - Posterior transverse carina of propodeum absent; ovipositor just basad of apical teeth smooth; fore wing crossvein 1cu-a basad of 1M+Rs by 0.3 its own length; fore wing vein 2-M distinctly shorter than vein 3-M; fore wing vein 2Cu much shorter than crossvein 2cu-a *Prosthoporus* Porter
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 - Clypeal margin centrally with one or two small teeth; first metasomal tergite relatively short and triangular, maximum length/(maximum width—minimum width) about 2.5–3.0 7
- 6(5). Propodeum polished, unsculptured, entirely devoided of carinae; hind wing vein 1-Cu somewhat shorter than crossvein cu-a; fore wing crossvein 1cu-a basad of 1M+Rs by 0.36 its length; fore wing vein 2-Cu with about same length as crossvein 2cu-a; fore wing vein 2-M approximately as long as vein 3-M *Trypha* Townes
 - Propodeum granulate to granulate-striate, the anterior transverse carina complete, al-

- most straight; hind wing vein 1-Cu distinctly longer than crossvein cu-a; fore wing crossvein 1cu-a narrowly basad or opposite vein 1M+Rs; fore wing vein 2-Cu greatly shortened, so that 3-Cu almost meets 1-Cu; fore wing vein 2-M distinctly longer than vein 3-M *Lagarosoma* Gupta et Gupta
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- Fore wing cell 1+2Rs very large, 0.50–0.95 as high as length of vein 2m-cu; fore wing vein 1-Rs+M with bulla apical, reaching cell 1+2Rs; fore wing hyaline, with three dark bands *Nesolinioceras* Ashmead
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- Fore wing crossveins 2r-m and 3r-m distinctly convergent towards anterior margin of wing; hind wing vein 1-Cu about twice as long as crossvein cu-a; fore wing vein 2-M approximately as long as vein 3-M *Fenixia* n. gen.

ACKNOWLEDGEMENTS

David B. Wahl contributed with valuable suggestions, guidance, and ideas to this work. Ian D. Gauld and Andrew Bennett also contributed on an earlier stage of the manuscript. Gavin R. Broad, Ilari E. Sääksjärvi, Donald L. J. Quicke and an anonymous reviewer read the submitted manuscript and returned very useful suggestions, corrections and information. Vinalto Graf and Gabriel A. R. Melo loaned the specimens, after allowing the author to search the entire DZUP collection for unsorted Gabuniina. Elisa Queiroz Garcia provided shelter and good company during the author's stay at DZUP. Luciana Musetti, David Wahl, Santosh Gupta and Andrew Bennett helped with the literature. Rogério Rosa da Silva kindly calculated the graph for Fig. 1. Funding for this project was provided by FAPESP (Brazil), paid directly to the author (Processes 00/05704-6 and 03/08585-6), or acquired from specific funds allocated to this work in a connected project of C. Roberto F. Brandão (FAPESP process 98/05083-0).

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Taxonomy, Biology, and Distribution of Seed Harvesting Ants in the *Pheidole californica* Complex (Hymenoptera: Formicidae)

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Abstract.—The *Pheidole californica* complex comprises three closely related and partly sympatric species of seed harvesting ants restricted to the western Nearctic region. An analysis of morphological variation in the minor workers and major workers (soldiers) reveals that these species are more variable than previously thought. Nevertheless, morphological characteristics were uncovered that are consistently diagnostic for each species. *Pheidole clementensis* Gregg may be distinguished from both *Pheidole californica* Mayr and *Pheidole creightoni* Gregg by the diagonal rather than longitudinal rugulae between the clypeus and the eye in lateral view. The closely related *P. californica* and *P. creightoni* are most readily distinguished from one another by the angle of their lateral cephalic setae. *Pheidole californica* has decumbent setae forming an angle of forty five degrees or less with the lateral margins of the head in full face view, while the cephalic setae of *P. creightoni* emerge at an angle of approximately ninety degrees. *Pheidole californica* is broadly distributed in the western Nearctic region. *Pheidole creightoni* and *P. clementensis* are more limited in their range, the former being found in foothill or plateau habitats in northern California, Oregon, Washington, and Nevada, while the latter is limited to foothill and coastal habitats of southern California and northern Baja California.

The cosmopolitan genus *Pheidole* is represented in the New World by more than 600 described species, which form a diverse and ecologically important component of many ant communities. Perhaps as a result of their dominance and diversity, the New World *Pheidole* have received considerable taxonomic attention (e.g., Mayr 1870, Emery 1895, Creighton 1950, Gregg 1959), culminating in a recent monograph (Wilson 2003) that more than doubled the number of described species.

Despite this attention the taxonomy of the New World *Pheidole* is not fully resolved. Many taxa are refractory to taxonomic characterization because of similarity between the species, as well as extensive intraspecific variation both within and among populations. *Pheidole californica*, *P. creightoni*, and *P. clementensis* comprise one such assemblage, here termed the *californica* complex, which is part of the larger “*pilifera* group” of Wilson (2003).

Among the three species included in this study, *P. californica* has both the largest geographic range and highest degree of intraspecific variation. In an attempt to encompass this variation, taxonomists of the late nineteenth and early twentieth century described additional species, and a number of subspecies and varieties (Emery 1895, Wheeler 1915, Cole 1933, 1936), although subsequent taxonomic work acknowledged the synonymy of most of these with *P. californica* (Creighton 1950, Gregg 1959, Wheeler and Wheeler 1986, Wilson 2003).

In spite of all this taxonomic attention *P. californica* remains a difficult ant to characterize, and the precise boundary between it and the other two species included in the study has never been rigorously examined. The purpose of the present contribution is to revise the taxonomy of the *californica* complex and to characterize

each species in a way that takes into account both intra- and interspecific variation.

MATERIALS AND METHODS

At the beginning of this study I traveled to sixteen localities in northern California, Washington, and western Nevada to intensively sample the *californica* complex. Between three and twelve nest series were obtained from each species at a given locality, along a transect that varied in length from one to twelve kilometers. The purpose of this sampling was to obtain baseline data on variation at the level of individual ants, colonies, populations, and species.

In addition to the material obtained specifically for this study, specimens were examined from the collections of Philip S. Ward (PSWC), the Bohart Museum of Entomology, University of California at Davis (UCDC), and the Los Angeles County Museum (LACM).

Measurements of specimens for use in the diagnoses and bivariate plots were taken at 50 \times using a Wild M5A microscope and a Nikon stage micrometer, and are presented to two decimal places. The following measurements and indices were utilized in this study:

- HL Head length: length of the head in full face view, measured from the anterior extremity of the clypeal margin to the midpoint of an imaginary line drawn across the posterior margin of the head (after Ward 2000).
- HW Head width: maximum width of head in full face (frontal) view, not including the eyes.
- CI Cephalic Index: HW/HL.
- EL Eye length: maximum diameter of the eye, measured with the head in lateral view.
- WE Relative eye length: EL/HL.
- PW Pronotum width: maximum width of pronotum, in dorsal view.

DML Dorsal mesosomal length: length of the mesosoma measured in dorsal view, from the anterior extremity of the pronotum near the articulation with the head to the posterior extremity of the propodeum (usually a cuticular flange near the articulation of the petiole). For this measurement, the specimen is adjusted in dorsal view so that the extremities of the pronotum and propodeum are simultaneously in focus.

PPW Postpetiolar width: maximum width of postpetiole in dorsal view.

SPECIES ACCOUNTS

The three species included in this study are members of the "*pilifera* group", a presumably monophyletic set of forty eight species of *Phaeole*, found almost exclusively in the Nearctic region, including Mexico (Wilson 2003). The group is characterized by reduced hypostomal teeth in the major, large eyes in the minor, and by the quadrate shape of the head in both major and minor (Wilson 2003). Within the *pilifera* group Wilson (2003) recognizes a cluster of species that he calls the "*pilifera* complex," which includes the species *P. calens*, *californica*, *carrollii*, *cavigenis*, *clementensis*, *creightoni*, *hoplitica*, *littoralis*, *micula*, *polymorpha*, *rugulosa*, *soritis*, *tepicana*, and *torosa*. Although it is unclear whether these species represent a monophyletic group, they are united by the traits (in the major) of extensive cephalic sculpture and, except in *P. carrollii* and *P. littoralis*, transverse rugulae or carinulae on the posterior cephalic vertex ("occipital lobes" in Wilson 2003). Within this cluster of species I recognize a group of three species, here termed the *californica* complex, united by the trait of *highly developed* transverse rugulae (see Wilson 2003: 23) on the cephalic dorsum of the major.

In 1915, W.M. Wheeler described *P. californica* subsp. *micula*. Gregg (1959) later recognized this as a distinct species, *P. micula*. Although I have not examined type

material for this species, I have concluded that *P. micula* is not a member of the *californica* complex, because it lacks highly developed transverse rugulae on the cephalic dorsum of the majors. In his recent monograph, E. O. Wilson (2003) describes the dorsal cephalic sculpture of *P. micula* majors as consisting of transverse *carinulae* that sometimes wrap downward at the sides of the head. Wilson also presents the caveat, in the form of a personal communication from Stefan Cover, that not all specimens of *P. micula* possess such extensive cephalic sculpture. *Pheidole californica*, *P. clementensis*, and *P. creightoni* are unique among the members of the *pilifera*-group in having majors with *highly developed* cephalic sculpture consisting of transverse rugulae, as opposed to *carinulae* (see Wilson 2003: 23), which cover the posterior cephalic vertex, extend at least one fourth of the way to the clypeus in full face view, and are at least partly visible in lateral view. Thus, I am leaving *P. micula* out of the *californica* complex. Nevertheless, the question of a possible affinity of *P. micula* with members of the *californica* complex warrants further examination.

The diagnoses presented in the following species accounts are a summary of morphological features that are usually characteristic of the species and therefore useful in identification. The features that are most consistently diagnostic of species are presented in **bold face**. Intraspecific variation in the remaining traits makes them less useful for identification. In addition, the illustrations (Figs. 5–21) should not be interpreted as comprehensive representations of the respective species. Cephalic sculpture and setae vary dramatically within these species, and most of the differences shown in these figures are not diagnostic for the species. Reliably diagnostic features are indicated in the figures with arrows.

Pheidole californica Mayr 1870
(Figs. 5–8, 21)

Pheidole californica Mayr 1870:987. Description of worker.

Pheidole oregonica Emery 1895:291. Synonymy by Wilson (2003:564).

Pheidole californica var. *incenata* Wheeler 1915:407. Synonymy by Creighton (1950:173).

Pheidole californica var. *satura* Wheeler 1915:407. Synonymy by Creighton (1950:173).

Pheidole californica subsp. *nevadensis* Wheeler 1915:408. Synonymy by Wheeler and Wheeler (1986:13).

Pheidole californica subsp. *pyramideusis* Emery 1922:105. Replacement name for subsp. *nevadensis* (junior primary homonym of *P. pubiventris* var. *nevadensis* Forel 1901:353). Synonymy by Wheeler and Wheeler (1986:13).

Pheidole californica var. *shoshoni* Cole 1933: 618. Synonymy by Gregg (1959:19).

Pheidole californica var. *hagermanii* Cole 1936: 35. Synonymy by Creighton (1950:173).

Pheidole californica Mayr; Wheeler and Wheeler 1972:243 (description of larva).

Major worker measurements ($n = 65$): HL 0.98–1.28, HW 0.86–1.21, CI 0.87–0.97, EL 0.14–0.22, REL 0.12–0.19, PrW 0.40–0.56, DML 0.83–1.07, PPW 0.17–0.31.

Diagnosis of major worker.—Head in full face view subquadrate. Lateral margins of head weakly to strongly convex. Lobes of posterior cephalic vertex weakly developed, and the notch of the vertex therefore shallow (Fig. 6); rugulae originating on the lateral clypeal margin straight and longitudinal; those rugulae originating on the part of the clypeus directly in front of the eye terminating abruptly at the eye (Fig. 5); eyes usually large in relation to the length of the head (Fig. 5); in full face view, setae emerging laterally from the head **decumbent**, forming an angle of forty five degrees or less with the integument (Fig. 6); propodeal spines in side view typically in the form of equilateral triangles produced from the lateral margination of the propodeum (Fig. 7).

Minor worker measurements ($n = 20$): HL 0.53–0.72, HW 0.47–0.66, CI 0.86–0.94, EL 0.12–0.16, REL 0.21–0.26, PrW 0.30–0.39, DML 0.67–0.79, PPW 0.12–0.18.

Diagnosis of minor worker.—Mesosoma elongate (DML 0.67–0.79); foveolate (see Wilson 2003: 22) sculpturing dense and

V. Chamberton); UC Santa Cruz campus, 230m (P. S. Ward); *Shasta Co.*: 1km WNW Lamoine, 630m (P. S. Ward); Enterprise, 175m (P. S. Ward); *Siskiyou Co.*: 17km SW Scott Bar, 640m (P. S. Ward); 26.8km S Tule Lake, 1420m (D. O. Burge); Weed (A. C. Cole); *Solano Co.*: 10km NE Dixon, 15m (P. S. Ward); 13km NW Dixon, 35m (P. S. Ward); 13km NW Rockville, 85m (P. S. Ward); Allendale (R. Waegell); Cold Canyon, 19km NNW Vacaville, 107m (D. O. Burge); Cold Canyon, 19km NNW Vacaville, 120m (P. S. Ward); Cold Canyon, 19km NNW Vacaville, 120m (D. M. Olson); Cold Canyon, 19km NNW Vacaville, 600m (P. S. Ward); Jepson Prairie, 18km S Dixon, 10m (P. S. Ward); South end of Lake Solano, 40m (R. Waegell); *Sonoma Co.*: 1km NNE Sonoma, 170m (P. S. Ward); 2km ENE Glen Ellen, 150m (P. S. Ward); 6km N Sonoma, 300m (P. S. Ward); Pepperwood Ranch, 15km N Santa Rosa, 360m (P. S. Ward); Sonoma, 25m (P. S. Ward); *Stanislaus Co.*: 22km WSW Patterson, 350m (D. O. Burge); Del Puerto Canyon, 22km WSW Patterson, 350m (P. S. Ward); Del Puerto Canyon, Frank Raines Regional Park, 340m (A. L. Wild); *Sutter Co.*: 7km NNW Sutter, 210m (P. S. Ward); *Tehama Co.*: 6km E Payne's Creek, 720m (P. S. Ward); 8.02km SSE Paynes Creek, 308m (D. O. Burge); 17.3km ESE Redbluff, 352m (D. O. Burge); hwy. 36, 5.8mi NE jct. w/hwy 99 (R. R. Snelling and P. Mehlhop); Redding (A. C. Cole); *Tuolumne Co.*: 3km SW Cold Springs, 1700m (P. S. Ward); 2mi W Chinese Camp (J. I. Stage); Sweetwater Campground, Stanislaus N.F. (S. Bloem); *Ventura Co.*: 29km WNW Stauffer, 1460m (P. S. Ward); *Yolo Co.*: 2.2km WSW Davis, 18m (D. O. Burge); 2km SSE Dobbins, 560m (P. S. Ward); 10km N Davis, 10m (P. S. Ward); 10km W Winters, 60m (P. S. Ward); 13km W Rumsey, 710m (P. S. Ward); Berryessa Peak, 930m (P. S. Ward); Davis (P. S. Ward); Grasslands Regional Park, 8km SE Davis, 10m (P. S. Ward); *Yuba Co.*: Sierra Foothill Range, 18mi NE Marysville (F. A. Ludtke). **Idaho**: *Elmore Co.*: 5.5mi E Hammett (R. R. Snelling); *Gooding Co.*: Hagerman (A. C. Cole); *Owyhee Co.*: 3.3mi S Given's Hot Springs (R. R. Snelling); *Twin Falls Co.*: Twin Falls (A. C. Cole). **Nevada**: *Humboldt Co.*: Calico Mtns., 35mi N Gerlach (W. S. Creighton); *Washoe Co.*: 5km S Nixon, 1185m (P. S. Ward); 8.67km W Nixon, 1140m (D. O. Burge); Hanging Rock Canyon, 1750m (P. S. Ward); S end Pyramid Lake, 1140m (P. S. Ward). **Oregon**: *Deschutes Co.*: Smith Rock State Park, 880m (P. S. Ward); *Josephine Co.*: 8km SSW Cave Junction, 430m (P. S. Ward); *Lake Co.*: 5mi S Plush (R. R. Snelling); *Wasco Co.*: Maupin (W. S. Creighton). **Utah**: *Salt Lake Co.*: Salt Lake City (Grundmann). **Washington**: *Adams Co.*: McManaman, 260m (P. S. Ward); *Grant Co.*: Frenchman, 260m (P. S. Ward); *King Co.*: Seatons, 260m (P. S. Ward); *King Co.*: Riverside, 290m (D. O. Burge); *Waukegan Co.*: Wawawai (W. M. Mann).

Pheidole creightoni Gregg 1955 (Figs. 13–16)

Pheidole creightoni Gregg 1955: 19 (w, q, m).

Major worker measurements (n = 34): HL 1.15–1.37, HW 1.05–1.30, CI 0.88–0.96, EL 0.17–0.21, REL 0.13–0.17, PrW 0.44–0.56, DML 0.94–1.10, PPW 0.25–0.42.

Diagnosis of major worker.—Head subquadrate in full face view (Fig. 14); lobes of the anterior cephalic vertex developed, so that in full face view the medial notch is pronounced (Fig. 14); rugulae that originate on the lateral clypeal margin straight and longitudinal; those rugulae originating on the part of the clypeus directly in front of the eye terminate abruptly at the eye (Fig. 13); eyes small in relation to the length of the head (REL 0.13–0.17; Fig. 13); due to the development of the lobes of the posterior cephalic vertex, eyes appear to be placed near the posterior clypeal margin, often within the first third or fourth of the length of the head in lateral view (Fig. 13); pilosity short and erect; in full face view, setae emerging laterally from the head erect, forming an angle of approximately ninety degrees with the integument (Fig. 14); propodeal spines in side view generally in the form of long blunt pegs (Fig. 15); lateral margination of the propodeum not usually well developed.

Minor worker measurements (n = 8): HL 0.53–0.62, HW 0.48–0.57, CI 0.89–0.93, EL 0.13–0.15, REL 0.22–0.26, PrW 0.31–0.35, DML 0.67–0.75, PPW 0.14–0.17.

Diagnosis of the minor worker.—Mesosoma elongate (DML 0.67–0.75); foveolate sculpturing patchy on the mesosoma in side view, interspersed on the metapleuron, mesopleuron, and propodeum with patches of smooth, shining integument; propodeal spines normally sharp and elongate (Fig. 16); lateral margination of the propodeum usually weakly developed.

Comments.—At five localities *P. creightoni* and *P. californica* are known to co-occur (Fig. 24). At four of these sites the species appear to be distinct, but at Dye

Creek, California, a fraction of the colonies (2 out of 9) sampled along a three kilometer transect yielded workers that were difficult to assign to either species. The morphology of these ants is curiously intermediate between *P. californica* and *P. creightoni*, "bridging the gap" between the two species. In general, the unusual colonies yielded workers with the size and coloration of *P. creightoni*, but with the decumbent lateral cephalic setae that are diagnostic of *P. californica*. In general, ants from the two unusual colonies resemble collections of *P. californica* (three out of nine colonies along the transect) much more than *P. creightoni* (four out of nine colonies along the transect), and they were treated as *P. californica* for the analysis of morphometric data.

The presence of typical *P. californica* and *P. creightoni* at Dye Creek points to hybridization as a possible explanation for the existence of morphologically intermediate colonies of *Pheidole* at that site. Within northern California, the range of *P. californica* appears to extend from the northern Sacramento Valley into the surrounding foothills and plateau areas, while the range of *P. creightoni* appears to extend from the foothill and plateau regions to the edge of the Sacramento Valley (see Fig. 24). It may be that the Dye Creek region forms part of a hybrid zone between the two species. Resolution of this problem will probably require both genetic analysis and more intensive sampling in the foothills area of northern California.

Material examined (PSWC, UCDC, LACM).

UNITED STATES **California:** *Mendocino Co.:* 4.59km NNE Hopland, 292m (D. O. Burge); 7.7km NNE Hopland, 825m (D. O. Burge); Hopland Field Station, 240m (P. S. Ward); *Siskiyou Co.:* 1.5mi NE Gazelle, 2600' (R. R. Snelling); Weed (A. C. Cole); *Tehama Co.:* 17.3km ESE Redbluff, 352m (D. O. Burge); 34.4km N Forest Ranch, 756m (D. O. Burge); *Trinity Co.:* Weaverville, Democrat Gulch (D. M. Gordon). **Nevada:** *Lander Co.:* Battle Mtn. (A. C. Cole); *Humboldt Co.:* Winemucca (A. C. Cole); *Lyon Co.:* Fort Churchill State Historic Park, 1280m (P. S. Ward);

Washoe Co.: 8.67km W Nixon, 1140m (D. O. Burge); S end Pyramid Lake, 1140m (P. S. Ward). **Oregon:** *Jackson Co.:* 3mi E Applegate (W. S. Creighton); *Josephine Co.:* 8km SSW Cave Junction, 430m (P. S. Ward). **Washington:** *Grant Co.:* Corfu (C. H. Lavers).

Pheidole clementensis Gregg 1969 (Figs. 17–20)

Pheidole clementensis Gregg 1969: 93 (w).

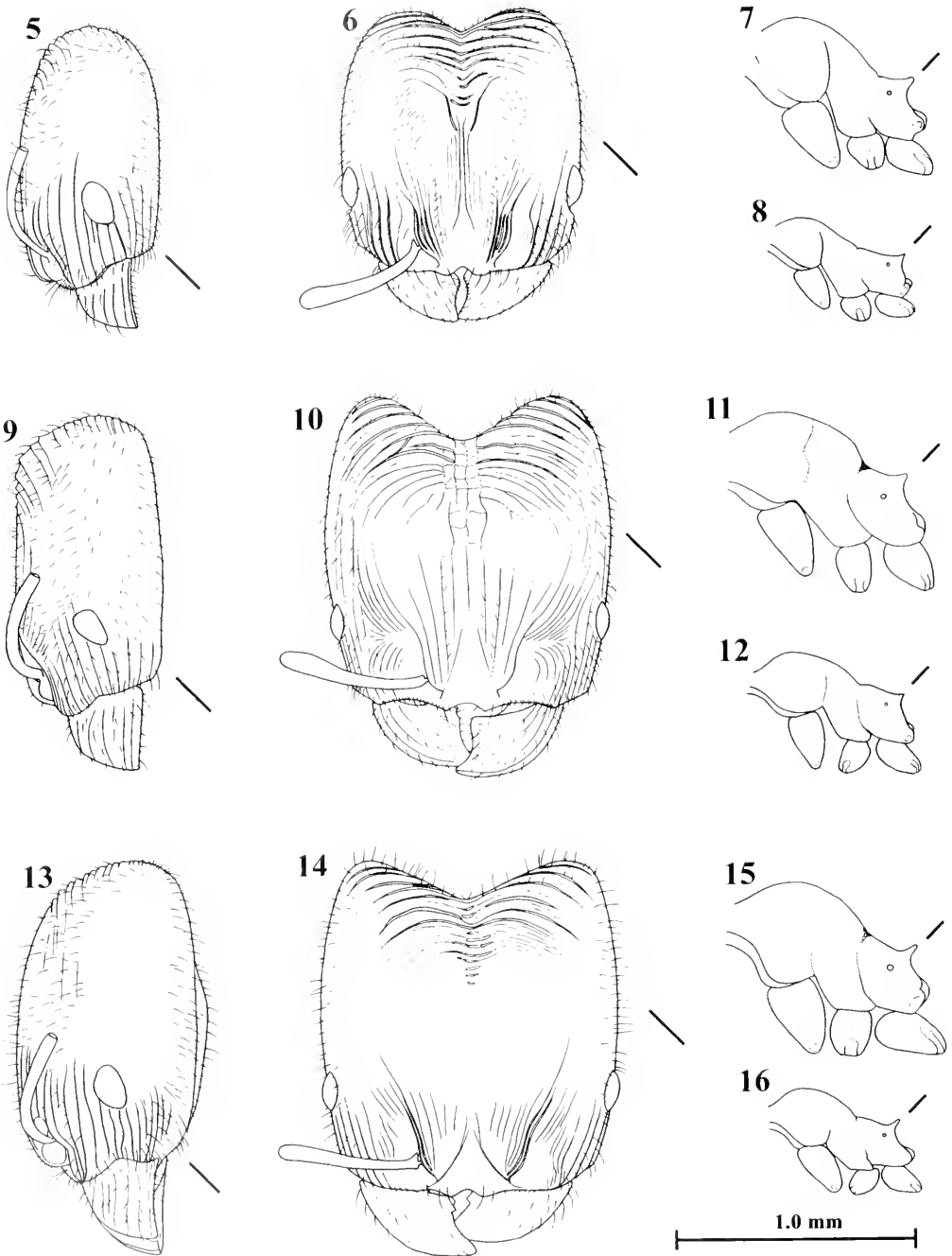
Major worker measurements (n = 14): HL 1.09–1.37, HW 0.94–1.23, CI 0.85–0.90, EL 0.14–0.18, REL 0.11–0.14, PrW 0.47–0.59, DML 0.92–1.11, PPW 0.23–0.34.

Diagnosis of major worker.—Head usually rectangular (subquadrate and elongate) in full face view, lateral margins parallel and only mildly convex (Fig. 18); transverse rugulae near the vertex of the head extremely coarse, such that in side view the head usually appears to have "brow ridges" (Fig. 17); in lateral view, rugulae originating on the part of the clypeus directly anterior to the eye arranged **diagonally** (rather than longitudinally), running towards the ventral surface of the head, below the eye (Fig. 17); eyes small relative to the length of the head (REL 0.11–0.14; Fig. 17); eyes located near the posterior clypeal margin, often within the first third or fourth of the length of the head in side view (Fig. 17); propodeal spines in side view generally in the form of long blunt pegs (Fig. 19); lateral margination of the propodeum usually weakly developed.

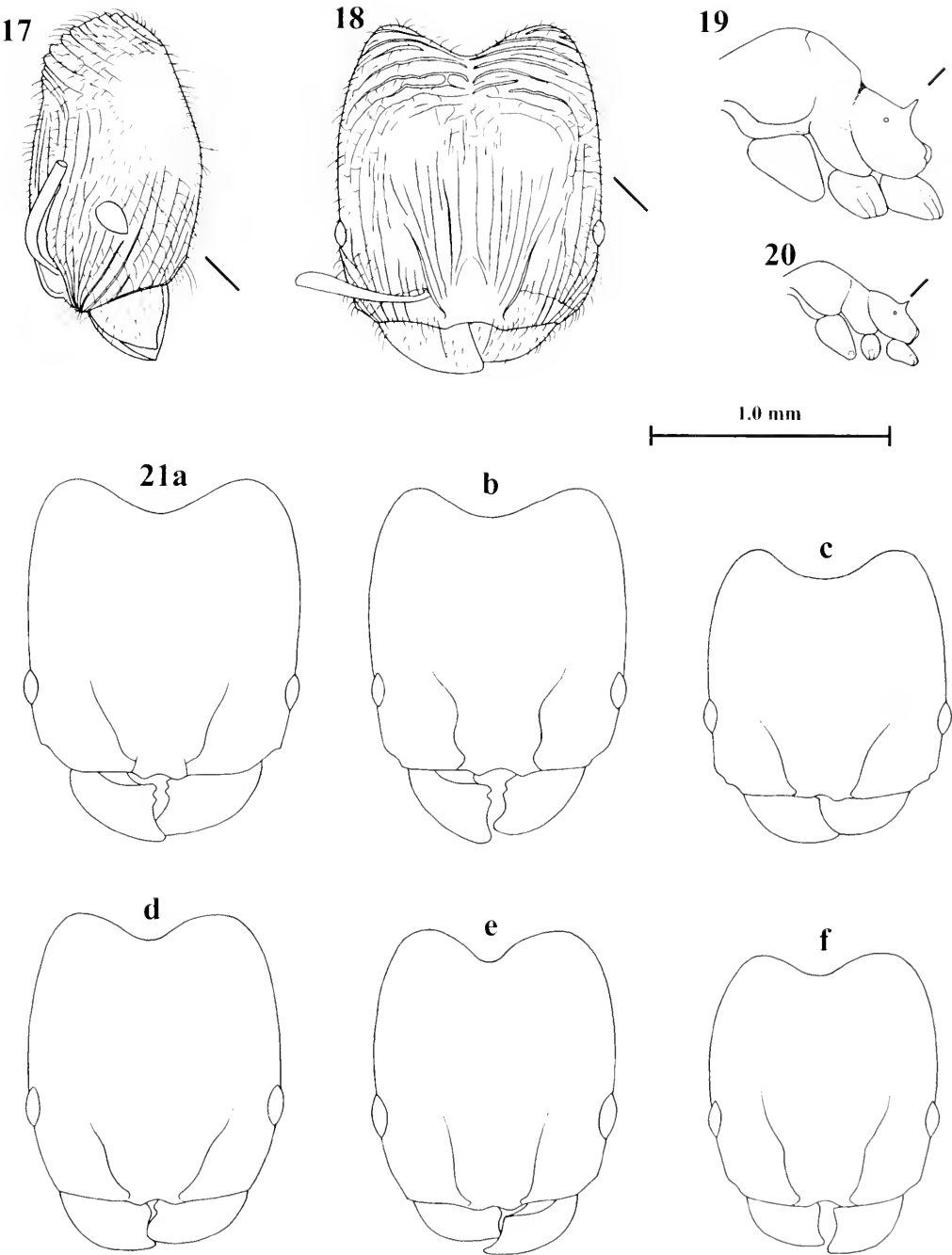
Minor worker measurements (n = 6): HL 0.52–0.61, HW 0.47–0.55, CI 0.89–0.92, EL 0.11–0.14, REL 0.19–0.22, PrW 0.30–0.35, DML 0.62–0.73, PPW 0.11–0.14.

Diagnosis of minor worker.—Mesosoma short (DML 0.62–0.73); foveolate sculpturing on the lateral mesosoma nearly non-existent, replaced by small, indistinct patches of sculpture mixed with more extensive areas of smooth and shining integument; propodeal spines short, thin, and sharp-tipped (Fig. 20); lateral margination of the propodeum usually weakly developed.

Comments.—Majors of *P. clementensis* may be distinguished from majors of *P.*



Figs. 5-16. *Pheidole* major workers, full face view of head (6, 10, 14), lateral view of head (5, 9, 13), and lateral view of mesosoma (7, 11, 15). *Pheidole* minor workers, lateral view of mesosoma (8, 12, 16). Note that sculpturing and setae of the antennal scapes and mesosoma have been omitted for clarity. 5-8: *P. californica*, 16.4 km ENE Chico, California; 9-12: *P. creightoni*-like variant of *P. californica*, 4.59 km NNE Hopland, California; 13-16: *P. creightoni*, 34.4 km N Forest Ranch, California.



Figs. 17–21. *Pheidole clementensis* major worker, full face view of head (18), lateral view of head (17), and lateral view of mesosoma (19). Minor worker, lateral view of mesosoma (20). *Pheidole californica* major workers, full face view of head with sculpture, pilosity, and antennae omitted (21a–f). 17–20: *P. clementensis*, Meling Ranch, Baja California, Mexico. 21a–c, three specimens of the *P. creightoni*-like variant of *P. californica*, from a single colony; 21d–f, three specimens of *P. californica* sensu stricto from a single colony. 21 a–f: 19km NNW Vacaville, California.

californica and *P. creightoni* by the angle of the rugulae between the eye and the clypeus in side view (see diagnoses). *Pheidole clementensis* overlaps more broadly with *P. californica* than *P. creightoni* for the metric measurements that were taken (see measurements in diagnoses), and bivariate plots tend to separate *P. creightoni* from *P. clementensis* more readily than they separate *P. californica* from *P. clementensis* (compare Figs. 1 and 2).

The range of *P. clementensis* overlaps broadly with the range of *P. californica* (Figs. 22–23), and the two species are sympatric at several sites. Although collections of the species from these sympatric zones are few, no intermediate forms are known, and hybridization does not appear to occur. The known range of *P. clementensis* is far removed from that of *P. creightoni* (Fig. 23).

Material examined (PSWC, UCDC, LACM).

MEXICO: Baja California: 8mi E El Rosario bridge (R. A. Johnson); Meling Ranch, 2450' (R. A. Johnson); Sierra San Borja 9.9mi N San Borja, 1970' (R. A. Johnson).

UNITED STATES: California: *Los Angeles Co.:* San Clemente Is., Pyramid Head (R. R. Snelling); *Orange Co.:* 1mi NW El Toro, 450' (R. J. Hamton); *Riverside Co.:* Lake Skinner, 462m (A. V. Suarez); Skinner Reservoir, 4470' (T. Prentice); *San Diego Co.:* Camp Pendleton (J. H. Hunt); Chula Vista (E end), 160m (P. S. Ward); Miramar Naval Air Station (T. Prentice).

IDENTIFICATION

The following short key may be used to differentiate major workers of the three species of the *californica* complex. All species have highly developed cephalic sculpture consisting of transverse rugulae that cover the posterior cephalic vertex, extend at least one fourth of the way to the clypeus in full face view, and are at least partly visible in lateral view.

-
1. Rugulae originating on lateral clypeal margin (directly anterior to eye) straight and longitudinal, terminating abruptly at the eye (Figs. 5, 9, 13) 2
 - Rugulae originating on lateral clypeal margin (directly anterior to eye) arranged diagonally rather than longitudinally, running *beneath* the eye (Fig. 17) *P. clementensis* Gregg
 2. In full face view, setae emerging laterally from the head *decumbent*, forming an angle of forty five degrees or less with the integument (Fig. 6) *P. californica* Mayr
 - In full face view, setae emerging laterally from the head *erect*, forming an angle of approximately ninety degrees with the integument (Fig. 14) *P. creightoni* Gregg
-

Gregg's (1959) key to the *Pheidole* of North America is also useful for identifying members of the *californica* complex. In light of newly discovered variation in critical traits, however, some couplets of the key must be modified. Couplets 23 and 27 refer to the development of the post petiolar connules, a trait that varies consider-

ably within *P. californica* and *P. creightoni*. In general, *P. creightoni* has more highly developed postpetiolar connules than *P. californica*, but the difference is not diagnostic. Couplet 27 of Gregg's key should be simplified to the following in order to prevent misidentification of *P. creightoni* that do not have well-developed postpetiolar connules.

-
27. Rugae on cephalic vertices of the major straight or wavy, but not reticulate; lateral postpetiolar connules *usually* very prominent 28
 - Rugae on cephalic vertices of the major notably reticulate and often coarse, but not reticulate; lateral postpetiolar connules *usually* blunt 29
-

Couplet 24, which is based on the head length (HL) of the major, must be modi-

fied in order to encompass newly discovered variation in this trait.

24. Head of major 0.85mm in length, or less	25
Head of major 0.98mm in length, or more	26

In their original form, couplets 33 and 34 of Gregg's key differentiate four subspecies of *P. californica*. As these subspecies are in synonymy with *P. californica*, I have provided a replacement for couplets 33 and 34 that now includes *P. clementensis*, which was described subsequent to the publication of Gregg's (1959) key. Although Gregg's (1969) description of *P. clementensis* includes a modification of the 1959 key that

is intended to separate the new species from *P. californica*, the "brow ridges" to which Gregg's couplet refers are not a consistent characteristic of the species. Some specimens of *P. californica* have similar sculpture, and specimens of *P. clementensis* without "brow ridges" are known from southern California. The following couplet (adapted from the short key above) should replace Gregg's couplets 33 and 34.

33. Rugulae originating on lateral clypeal margin (directly anterior to eye) arranged diagonally rather than longitudinally, running <i>beneath</i> the eye (Fig. 17)	<i>P. clementensis</i> Gregg
– Rugulae originating on lateral clypeal margin (directly anterior to eye) straight and longitudinal, terminating abruptly at the eye (Fig. 5)	<i>P. californica</i> Mayr

BIOLOGY AND DISTRIBUTION

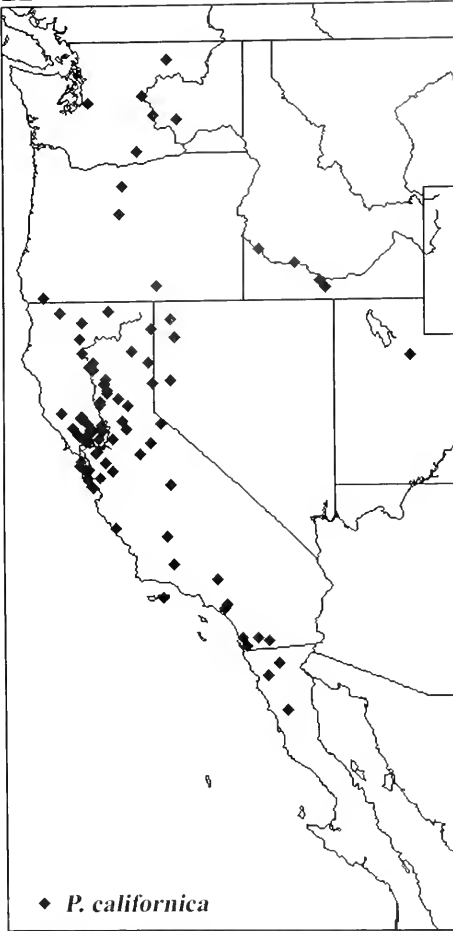
The biological observations included in the following synopses are those that appear to be characteristic of the species. Nevertheless, these traits vary considerably within each species. Distribution data are based on my own collections and information associated with specimens that I examined in existing collections, which means that they are biased towards accessible areas. Thus, gaps on each map may indicate a lack of field work within a particular region rather than a true gap in the distribution of the species.

Pheidole californica.—This species is found in the greatest diversity of habitats, from valley grasslands to higher elevation mountainous or plateau areas (5 to 1750m, mean = 600m) in Arizona, California, Idaho, Nevada, Oregon, Utah, Washington,

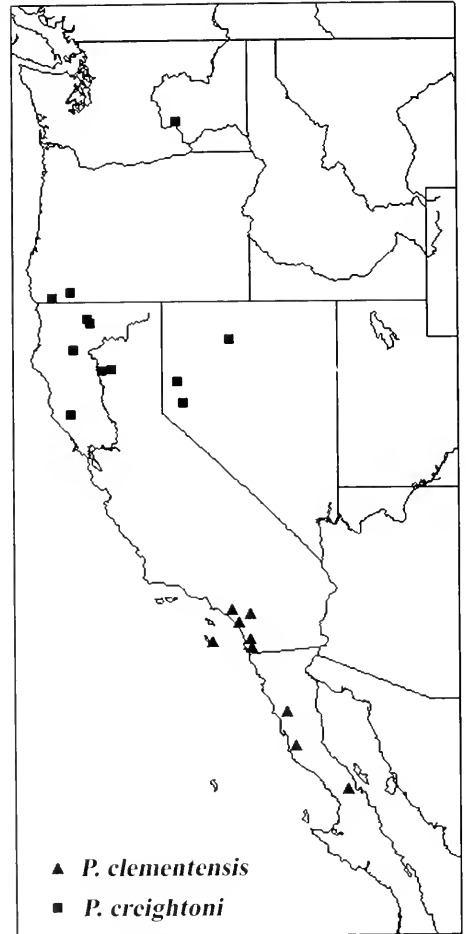
and Baja California (Fig. 22). *Pheidole californica* readily colonizes disturbed habitats such as road verges, fallow fields, and vacant lots. Nest entrances are usually small and inconspicuous, making them difficult to find except when they are located in patches of bare soil. Midden piles are accumulated, but this species does not usually collect chaff around the nest in the manner of *P. creightoni*. Foraging usually takes place in the evening and during the night. Foraging is conducted primarily by minor workers. Nuptial flights tend to occur in the evening and early night at most localities. In Davis, California, nuptial flights at a specific group of colonies were observed to begin in early May, and continue sporadically until late June.

Pheidole creightoni.—This species is found in foothill, mountain, and plateau

22



23

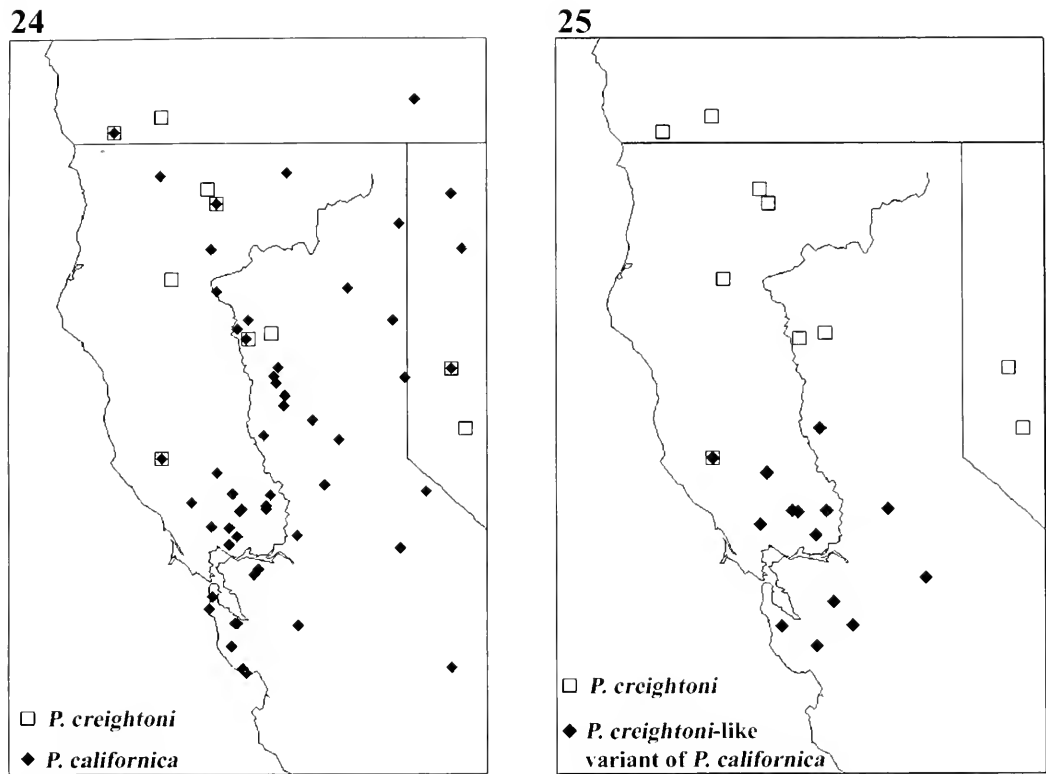


Figs. 22–23. Known distributions in the western United States and northern Mexico of *Pheidole californica* (22), and *P. creightoni* and *P. clementensis* (23).

areas of California, Oregon, Washington, and Nevada (Fig. 23) at a higher average elevation than *P. californica* (300 to 1300m, mean = 725m). *Pheidole creightoni* is often found in less disturbed habitats than *P. californica*. Nest entrances are conspicuous, and usually located within tufts of grass or at the edge of partially buried stones. Significant amounts of discarded seed chaff are usually associated with nests, forming a soft “crater” around the entrance, or a mound adjacent to the nest. The foraging habits of *P. creightoni* are similar to those of *P. californica*, although foraging columns of the former tend to

contain a higher proportion of major workers.

At several study sites where *P. creightoni* co-occurs with the seed harvesting ant *Messor andrei* (Mayr) these species tend to nest in close proximity. This phenomenon was first noted by W. S. Creighton, who originally collected *P. creightoni* in southern Oregon (Gregg 1955). At both Dye Creek and Hopland Research and Extension Center, California, *P. creightoni* colonies were discovered in close proximity to *M. andrei* nests. In one instance at Hopland Research and Extension Center, a mature colony of *P. creightoni* was located



Figs 24–25. Known distributions in northern California, western Nevada, and southern Oregon of *P. californica* and *P. creightoni* (24), and *P. creightoni* and the *P. creightoni*-like variant of *P. californica* (25).

only 20cm from the entrance of a large and active colony of *M. andrei*, the *Pheidole* nest being surrounded by the chaff piles and foraging trails of *M. andrei*. Colonies of *P. californica* were never observed in close proximity to nests of *M. andrei*. Given that *P. creightoni* and *M. andrei* are both seed harvesting species, and thus potential competitors, it seems paradoxical that they would preferentially nest in close proximity to one another.

Pheidole clementensis.—This species is found in arid and semi-arid habitats of southern California and northern Baja California (Fig. 23) at moderate elevations (160 to 800m, mean = 530m). Based on collection data from specimens examined, nesting is most often beneath stones, but the author has not made any personal observations.

DISCUSSION AND CONCLUSIONS

Pheidole californica is the most variable member of the *californica* complex at both the local and geographic scale, with marked differences in morphology among populations, among nests within a population, and among the members of a single colony. In spite of this variability, which has led to poor characterization of the species and confusion with other members of the complex, I have identified some traits that consistently separate *P. californica* from its closest relatives.

High levels of morphological variation in *P. californica* may be correlated with the large range of the species. It is possible that barriers to dispersal within the wide geographical range of *P. californica* have led to divergence in this species, while the comparatively small range of *P. creightoni*

and *P. clementensis* has led to a correspondingly lower amount of variation.

Another possible source of variation in the *californica* complex is hybridization between species. At several localities *P. californica* and *P. creightoni* are sympatric, and at one of these sites there is some evidence of hybridization. Thus, it may be that the confusing variation among and within some populations of *P. californica* is partly due to the influence of introgression with *P. creightoni*. Genetic work may be required for the resolution of this and other questions related to variation in members of the *californica* complex.

ACKNOWLEDGEMENTS

I would like to thank Philip Ward (PSWC and UCDC) and Roy Snelling (LACM) for providing access to material in collections. Useful material was also provided by Alex Wild and Emma Underwood. I want to specially thank my advisor Philip Ward for inspiration and guidance throughout this project. The following organizations helped make this project possible by granting permission to collect ants on their land, and by providing additional assistance with field logistics: the Pyramid Lake Paiute Tribe, The Nature Conservancy (Dye Creek Preserve, Lassen Foothills), and The University of California (Hopland Research and Extension Center). Funding for the project was provided by the President's Undergraduate Fellowship program at the University of California, Davis.

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A Review of the Species of the New World Braconid Genus *Cyclaulacidea* (Hymenoptera) with Key and Descriptions of Nine New Species

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Abstract.—The Neotropical parasitic wasp genus *Cyclaulacidea* Quicke & Delobel (Hymenoptera: Braconidae) contains two previously described species from Peru and Brazil that are known to feed on Bruchidae and Curculionidae associated with palms. An examination of Neotropical braconines from 19 insect collections reveals that species of *Cyclaulacidea* are much more widespread. Nine new species of *Cyclaulacidea* are described, and an identification key to the eleven known species is provided. The new species are: *C. pottsae* from Mexico; *C. adairae*, *C. hunteri*, and *C. snyderorum* from Costa Rica; *C. fergusonii* from Panama; *C. picki*, *C. rominus*, and *C. sharkeyi* from Suriname; and *C. riceorum* from Peru and Brazil. The range of *C. bruchivorus* Quicke is expanded from Peru to include Brazil, Bolivia, and Suriname, and that of *C. matilei* Villemant and Simbolotti is expanded from Brazil to Colombia.

Cyclaulacidea Quicke and Delobel currently contains two species of wasps that are ectoparasitic on Coleoptera feeding on palms (Quicke 1997, Villemant and Simbolotti 2000). *Cyclaulacidea bruchivorus* Quicke has been reared in Peru from *Caryoborus serripes* Sturm (Bruchidae: Pachymerinae) feeding on fruits fallen from *Astrocaryum javarense* Trail ex Drude, *A. chonta* Martins, and *A. macrocalyx* Burret (Quicke and Delobel 1995). *Cyclaulacidea matilei* Villemant and Simbolotti has been reared from *Foveolus* sp. (Curculionidae: Rhynchophorinae: Sphenophorini) feeding in floral bracts of *Euterpe oleracea* C. Martius (Villemant and Simbolotti 2000). Neither species has been documented outside of its type locality country.

Cyclaulacidea is part of the *Compsobracon* Ashmead group of Neotropical parasitic wasps (Braconidae: Braconinae), a diverse group of at least 100 species that vary from the enormous, brightly colored species of *Compsobracon* to the tiny and inconspicuous species of *Compsobraconoides* Quicke. The *Compsobracon* group currently

contains 33 described species that share a unique facial sculpture of paired ridges that run from the antennal sockets to the clypeus (Figs. 2, 3, 4) and which are divided into seven genera: *Compsobracon*, *Calobracon* Szépligeti, *Cyclaulax* Cameron, *Compsobraconoides*, *Cyclaulacidea*, *Gracilibracon* Quicke, and *Sacirema* Quicke (Quicke 1997).

METHODS

Specimens examined.—As part of a generic-level revision of the entire *Compsobracon* group, 4,918 specimens of Neotropical Braconinae were borrowed from 19 insect collections. Additionally, the senior author recently had the opportunity to examine type specimens of *C. bruchivorus* and *C. matilei* during a visit to the Musée National d'Histoire Naturelle in Paris. Specimens from the *Compsobracon* group used in this study are marked with unique numbers on their determination labels in the format JL##### to allow the continued association of notes and observed character states with particular specimens.

Table 1. Summary of meristic and continuous measurements in species of *Cyclaulacidea*. L = length, W = width, D = distance, H = height, FW = Fore wing.

	<i>adai.</i>	<i>bruc</i>	<i>ferg.</i>	<i>hunt.</i>
Length (mm)	7.0–8.3	7.0–12.7	8.6	7.0–7.5
Flagellomeres	42–45	49–63	46	42
Scape L:W	1.5–2.0	1.7–2.2	2.1	1.8–2.1
First:second flagellomere	1.2–1.4	1.2–1.7	1.4	1.3–1.4
First:third flagellomere	1.3–1.6	1.3–1.7	1.5	1.4–1.5
Third flagellomere L:W	1.0–1.3	0.9–1.3	1.5	1.1
Apical flagellomere L:W	1.5–1.8	1.8–2.2	1.8	1.6
Horizontal L eye: L of head behind eye	1.6–2.2	0.9–1.2	1.6	1.5
Diameter posterior ocellus: post-ocellar L	0.9–1.5	1.0–1.5	0.8	1.0–1.2
D between posterior ocellus and eye: post-ocellar L	2.9–3.8	3.4–4.3	2.6	3.9–4.9
Eye H:W	1.2–1.3	1.3–1.4	1.2	1.3–1.4
Eye H:W of face	1.2–1.5	1.1–1.6	1.5	1.4
W of head:W of face	2.2–2.8	2.0–2.8	2.6	2.4
Inter-tentorial D:clypeus H	2.0–2.4	1.8–2.2	2.4	2.2–2.3
Tentorio-ocular D:clypeus H	0.8–1.1	0.8–1.2	0.9	1.1
Face W:H	0.9–1.2	1.0–1.2	0.9	0.9–1.0
Malar space:eye H	0.2–0.3	0.1–0.2	0.2	0.1–0.2
Mesosoma L:H	1.3–1.5	1.4–1.7	1.6	1.4
Propodeal spiracle H:W	2.5–3.3	2.0–2.7	2.3	2.0–2.2
Foretibia L:forefemur L	1.1–1.2	1.1–1.2	1.0	1.1
Foretarsus L:forefemur L	1.5–1.6	1.5–1.7	1.6	1.6
Fore basitarsus L:W	3.7–5.0	3.9–5.7	4.7	4.2–4.8
Fore basitarsus L:second tarsomere L	1.6–1.8	1.5–1.8	2.0	1.6–1.7
Hind femur L:W	3.8–4.2	3.7–4.0	4.0	3.6–4.0
Hind femur L:hind basitarsus L	2.0–2.4	1.6–1.9	1.9	1.8–2.7
Hind tibia:hind basitarsus L	2.5–2.9	2.3–2.8	2.7	2.4–2.7
Outer tibial spur L:basitarsus L	0.5–0.6	0.3–0.5	0.4	0.5
Inner tibial spur L:basitarsus L	0.6–0.7	0.6	0.6	0.7
Hind basitarsus L:W	3.4–4.1	5.4–7.3	4.6	4.0–4.7
FW 1M:1RS L	1.7–2.5	1.5–2.3	2.4	1.9–2.0
FW 2M:r-m L	3.5–4.1	3.1–4.1	4.2	3.4–3.5
FW 1m-cu:r L	1.2–1.6	1.0–1.4	1.3	1.1–1.2
FW 1m-cu:(RS+M)a thickness	1.5–2.2	1.0–2.0	1.5	1.2–1.4
FW 2RS:r-m L	1.3–1.5	1.0–1.2	1.5	1.1–1.2
FW 3RSa:r-m L	3.0–3.4	2.7–3.6	3.3	3.0
FW 3RSa:r L	4.6–6.2	4.5–5.7	4.8	4.8–5.3
FW 3RSb:r L	6.0–7.6	4.4–6.0	5.8	5.1–5.5
FW L	6.9–8.0	8.6–12.0	7.8	7.0–7.5
Hind wing vein R1a:1r-m L	1.3–1.8	1.1–1.4	1.4	1.5–1.6
First tergite L:W	0.9–1.1	0.7–1.2	0.8	0.8–0.9
Second tergite L:W	0.4–0.5	0.4–0.5	0.5	0.4–0.5
Second tergite L:third tergite L	0.7–0.9	0.6–0.8	0.7	0.8–0.9
Third tergite L:W	0.5–0.6	0.5–0.7	0.7	0.5–0.6
Ovipositor:body L	0.8–1.0	1.4–1.5	♂	1.1–1.2

These numbers are included for type specimens in the species descriptions and are included in the distribution section (Appendix 1) for new specimens of *C. bruchi-vornis* and *C. matilei*.

Because resources for the identification

of New World braconines are sparse and *Cyclaulacidea* was only recently described, specimens of *Cyclaulacidea* are rare in collections. Several of the species described herein are represented only by single specimens. Single specimens were recog-

Table 1. Continued.

<i>mat.</i>	<i>pick.</i>	<i>pott.</i>	<i>rice.</i>	<i>roni.</i>	<i>shar.</i>	<i>snjd.</i>
7.0-9.5	10.3	8.0	7.8-10.1	8.8-9.6	8.8-14.1	7.2-9.2
46-54	BR	46	48-52	48-53	54-58	46-52
1.3-2.5	1.8	1.5	1.7-2.1	1.6-1.7	1.9-2.3	1.8-1.9
1.3-1.4	1.3	1.4	1.3-1.5	1.2-1.4	1.2-1.5	1.3-1.4
1.4-1.5	1.3	1.5	1.4-1.6	1.3-1.4	1.4-1.6	1.4
1.1	1.5	1.1	1.2-1.3	1.0-1.1	1.1-1.3	1.1-1.3
1.6-1.8	BR	1.7	1.8-2.9	1.8-1.9	1.8-2.3	1.8-1.9
1.7	0.9	1.5	1.0-1.4	1.4-1.7	0.7-0.8	1.7
1.2	1.6	0.8	0.9-1.2	1.0-1.1	0.9-1.4	0.9-1.1
4.3	5.3	2.9	2.8-4.0	3.5	3.8-5.6	2.9-3.3
1.2	1.3	1.3	1.3-1.4	1.3	1.3-1.5	1.3
1.1-1.3	1.3	1.2	1.2-1.7	1.2	1.0-1.2	1.3
2.0-2.3	2.4	2.3	2.1-2.7	2.2	1.9-2.3	2.3-2.4
2.7-3.2	2.5	2.5	1.9-3.1	2.0-2.3	1.7-2.3	2.5-2.8
1.0-1.5	1.1	1.3	0.7-1.1	1.0-1.1	1.0-1.3	1.1-1.2
1.3	1.0	1.1	0.7-1.1	1.1-1.2	1.1-1.2	1.0-1.1
0.2	0.2	0.2	0.1-0.2	0.2	0.2-0.3	0.2
1.5-1.9	1.6	1.5	1.6-1.7	1.4-1.5	1.4-1.7	1.5-1.6
3.3	1.9	2.0	2.0-2.5	2.7-3.2	1.8-2.4	1.9-2.3
1.1-1.2	1.1	1.2	1.1-1.2	1.1-1.2	1.0-1.2	1.1-1.2
1.4-1.6	1.7	1.6	1.6-1.7	1.6-1.7	1.5-1.7	1.6-1.7
4.3	5.2	4.2	4.3-5.4	3.3-4.3	3.9-5.7	4.5-5.1
1.7	1.7	1.8	1.5-1.8	1.6-1.7	1.7-1.9	1.5-1.8
4.0	4.1	3.8	3.8-4.0	3.7-4.1	3.8-4.2	4.0-4.4
1.8	1.5	1.8	1.6-1.8	1.9-2.1	1.6-1.8	1.7-1.8
2.4	2.6	2.6	2.3-2.7	2.5-2.6	2.5-2.6	2.4-2.6
0.4-0.5	0.3	0.4	0.4-0.5	0.5	0.4	0.4-0.5
0.6	0.5	0.6	0.6	0.6-0.7	0.5-0.6	0.6
6.0	5.5	5.5	5.0-6.2	4.2-4.5	5.2-6.2	4.4-5.2
1.7	2.3	2.1	1.9-2.1	1.5-1.7	1.8-2.1	1.7-2.1
3.3	3.5	3.6	3.3-3.8	3.3-3.8	3.1-3.6	3.2-3.5
1.1-1.3	1.3	1.1	1.0-1.5	1.0	1.2-1.6	0.9-1.3
1.6	1.7	1.8	1.1-2.2	1.5-2.0	1.1-1.7	1.5-1.6
1.1	1.2	1.1	1.2-1.3	1.0-1.2	1.0-1.2	1.1-1.2
2.9	2.9	3.2	2.7-3.2	2.8-3.1	2.9-3.2	2.8-2.9
4.1-4.7	4.8	5.1	4.3-6.2	4.0-4.4	5.0-6.3	3.8-5.4
4.9-5.7	5.4	4.7	5.2-7.2	4.6-5.0	4.6-6.0	4.1-5.4
9.7	9.0	7.6	7.3-8.6	9.0-10.3	8.7-12.8	7.0-9.1
1.5-1.8	1.8	1.5	1.4-1.6	1.4	1.3-1.5	1.2-1.4
0.9-1.2	1.1	0.9	0.8-1.1	0.9-1.0	1.1-1.3	0.8-0.9
0.4-0.8	0.7	0.5	0.5-0.6	0.4-0.5	0.5-0.6	0.4-0.5
0.7	1.4	0.7	0.7-0.9	0.7-0.9	0.7-0.9	0.7-0.8
0.4	0.5	0.6	0.6-0.7	0.5-0.6	0.5-0.7	0.5-0.6
1.0	1.1	1.0	1.2	0.9	0.8-1.1	1.1

nized as new species only when they possessed unique combinations of at least several characters and had a disjunct geographic distribution. All of the known specimens of *Cyclaulacidea* are in good condition, although a few of the older

ones are moderately dusty (e.g., Fig. 3B). Several museums have large collections of unsorted Neotropical braconines (e.g., the American Entomological Institute). There are undoubtedly additional species of *Cyclaulacidea* that await description

when funding is available to curate these accessions.

Morphology.—Morphological terminology and character systems examined follow Sharkey and Wharton (1997), with the exception of morphometric characters, which follow van Achterberg (1979). As part of a larger study of the *Compsobracon* group of New World Braconinae, all specimens of *Cyclaulacidea* were examined for a total of 68 discrete, 44 continuous, and 3 meristic morphological characters, as well as 41 color characters. Continuous characters were measured using a Microcode II (Boeckeler Instruments). Length was measured from head to abdomen. Measures of face height were measured from the tentorial pits rather than the top of the clypeus. Meristic and continuous data is included in the species descriptions and summarized in Table 1. The angle θ of Fore wing veins C+SC+R and 1RS was estimated using the formula $\tan^{-1}\theta = ((\text{distance from intersection of 1RS and (RS+M)} \text{ a to C+SC+R in a basad direction measured perpendicular to 1RS}) / (\text{length of 1RS}))$ (Fig. 6A). The species descriptions include character states from both holotypes and paratypes. When there is variation in this data holotype information is denoted in square brackets.

In many braconines the clypeus is separated from the rest of the face by a raised ridge (as in Fig. 4A). Furthermore, in some species of *Cyclaulacidea* the clypeus is also elevated such that parts of it are level with this ridge. In the species descriptions 'clypeus partially filled in dorsally' means that the part of the clypeus closest to the face is level with this ridge and the part closest to the labrum appears excavated and is not level with the ridge (as in Fig. 2B).

Depositories.—Specimens of *Cyclaulacidea* were found in the following museums. The acronyms used here are taken from Arnett et. al. (1993): California Academy of Sciences, San Francisco, California, USA

(CAS); Entomological Museum, Utah State University, Logan, Utah, USA (EMUS); Rocky Mountain Systematic Entomology Laboratory, University of Wyoming, Laramie, Wyoming, USA (ESUW); Instituto Alexander von Humboldt, Santafé de Bogotá, Colombia (IAVH); Musée National d'Histoire Naturelle, Paris, France (MNHN); Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZSP); Oregon State Arthropod Collection, Oregon State University, Corvallis, Oregon, USA (OSUO); Nationaal Natuurhistorische Museum, Leiden, Netherlands (RMNH); Department of Entomology Insect Collection, Texas A&M University, College Station, Texas, USA (TAMU); National Museum of Natural History, Smithsonian Institution, Washington D.C., USA (USNM).

RESULTS

Of the 4,918 specimens of Braconinae examined, 1,133 are members of the *Compsobracon* group, but only 41 are members of *Cyclaulacidea*. Additional specimens of *C. bruchivorus* and *C. matilei* are among these specimens, as are 9 species new to science. No information on host association or other ecological data are recorded on the labels of any specimens of the new species.

DISTRIBUTION

Specimens of *Cyclaulacidea*, previously documented from only Peru and Brazil, are reported from Mexico, Costa Rica, Panama, Colombia, Suriname, and Bolivia (Fig. 1). The range of *C. bruchivorus* is expanded from Peru to include Brazil, Bolivia, and Suriname (Fig. 1, Appendix 1). The only new specimen of *C. matilei* bears collection information from Colombia (Fig. 1, Appendix 1).

SYSTEMATICS

Cyclaulacidea Quicke & Delobel

Cyclaulacidea Quicke & Delobel, 1995: 218–219.

Diagnosis.—Species of *Cyclaulacidea* can

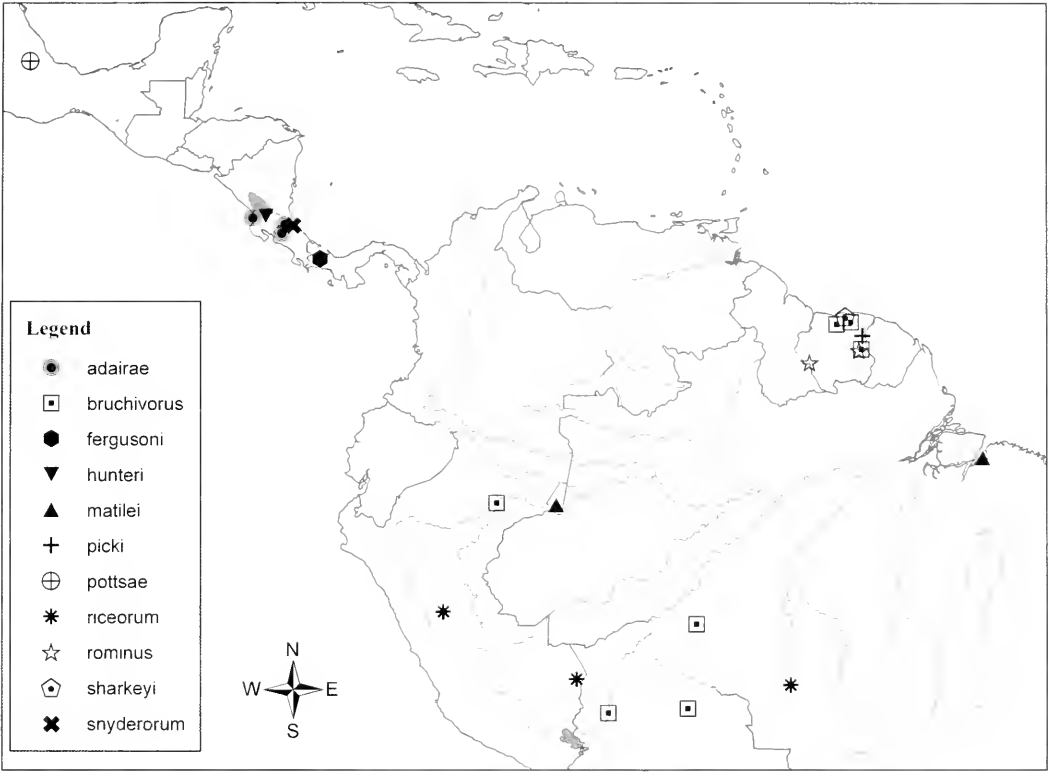


Fig. 1. Distribution map for species of *Cyclaulacidea*.

be distinguished from other genera of Bracninae using the key of Quicke (1997) and by the presence of the following putative synapomorphies: a median ridge on the face is developed into a raised tear-drop, chevron, or butterfly-shaped area (Figs. 2, 3, 4) and the first tergite has a strongly raised median rectangular to tongue-shaped area (Figs. 8A, 8B, 8C). One of the new species, *C. adairae*, keys to *Compsobraconoides* in Quicke's key due to the shape of its scape; however, this taxon is much larger than any species of *Compsobraconoides* and possesses the tear-drop shaped area on the face and rectangular bump on the first tergite characteristic of *Cyclaulacidea*.

All known species of *Cyclaulacidea* also possess the following combination of characters:

HEAD: Pedicel not swollen or heavily sclerotized. Scape lacking basal concavity.

First flagellomere swollen basally toward vertex of head. Apical flagellomere aciculate. Antennal sockets not extended from head, lacking plate-like shelf and enlarged sockets. Vertex of head with smooth depression and groove medially. The face is glabrous and has a pair of main, submedial, longitudinal ridges running from the clypeus to the antennal sockets (Figs. 2, 3, 4). Area between ridges and eyes with ladder-like series of horizontal carinae. Clypeus separated from rest of face by rugose ridge.

MESOSOMA: Metanotum mostly smooth. Propodeum lacking median longitudinal carina. Tarsal claw with very small basal lobe. Hind tibia lacking longitudinal depression. Hind telotarsus lacking especially thick setae. Fore wing vein (RS+M)a is strongly curved (Fig. 6). Hind wing with 1 basal hamulus and an area of reduced setosity apicad to vein cu-a.

METASOMA: First tergite trapezoidal, lacking median longitudinal and Y-shaped carinae. Second median tergite lacking raised mid-basal triangular area pointing posteriorly or anteriorly. Apical

branch of suturiform articulation absent. Third tergite smooth, lacking pinched-up area, median longitudinal carina, and mid-basal triangular area. Hypopygium pointed apically.

KEY TO SPECIES OF CYCLAULACIDEA

1. Fore wing entirely black (as in Fig. 10B) or black with one clear band (Fig. 12B) 2
 - Fore wing with two yellow (as in Fig. 11) or clear bands (as in Fig. 12C) 5
- 2(1). Fore wing with one clear band in apical third; maxillary and labial palpomeres black basally, yellowish orange apically; (Fig. 12B) *C. pottsae* n. sp.
 - Fore wing entirely black (as in Fig. 10B); maxillary and labial palpomeres entirely black or entirely white 3
- 3(2). Terga 4-6 black dorsally, yellowish orange laterally; maxillary and labial palpomeres entirely white; suturiform articulation represented by a deep groove (Fig. 7A); fore tarsus strongly laterally compressed (Figs. 5A, 5B); (Fig. 10B) *C. fergusonii* n. sp.
 - Terga 4-6 entirely black; maxillary and labial palpomeres entirely black; suturiform articulation represented by weak groove (as in Fig. 7B); fore tarsus not strongly laterally compressed (as in Figs. 5C, 5D) 4
- 4(3). Scape longer dorsally than ventrally (Fig. 5E); rectangular bump on petiole narrowing posteriorly (Fig. 8A); main, submedial, longitudinal facial ridges bowed outward (Fig. 2A); median carina on face developed into tear-drop shaped area medially (Fig. 2A); (Fig. 10D) *C. adairae* n. sp.
 - Scape longer ventrally than dorsally (Fig. 5F); rectangular bump on petiole not narrowing posteriorly (Fig. 8B); main, submedial, longitudinal facial ridges diverging outward straight from clypeus to antennal sockets (Fig. 3A); median carina on face developed into chevron to butterfly-shaped area medially (Fig. 3A); (Fig. 10C) *C. snyderorum* n. sp.
- 5(1). Mesosoma entirely yellowish orange 6
 - Mesosoma entirely black, or mostly black with some yellowish orange on dorsal surface and around margins of pronotum, tegula, and/or sternaulus 7
- 6(5). Sutureform articulation barely distinguished from terga 2 and 3, lacking groove (Fig. 7C); bump on petiole tongue-shaped, wider posteriorly than anteriorly (Fig. 8C); main, submedial, longitudinal facial ridges bowed outward (as in Figs. 2A, 2B); ovipositor sheath entirely black; (Fig. 12C) *C. picki* n. sp.
 - Sutureform articulation with shallow groove (as in Fig. 7B); bump on petiole rectangular (as in Fig. 8B); main, submedial, longitudinal facial ridges parallel (Fig. 3B) or diverging straight from clypeus to antennal sockets (as in Fig. 3A); ovipositor sheath black with some yellowish orange in apical third (but black at apical tip); (Fig. 12A) *C. sharkeyi* n.sp.
- 7(5). Forecoxa usually entirely yellowish orange, sometimes with some black basally; mid femur entirely yellowish orange; Fore wing vein 1cu-a intersects Cu distad 1M (as in Fig. 6A) 8
 - Forecoxa usually entirely black, sometimes yellowish orange; mid femur usually entirely black, sometimes with yellowish orange on basal and apical ends, or entirely yellowish orange; Fore wing veins 1M and 1cu-a intersect (interstitial) (as in Fig. 6B) 9

- 8(7). Inter-tentorial distance 1.8–2.2 times greater than clypeus height (Fig. 4A); maxillary and labial palpomeres entirely yellowish orange to white; (Fig. 11A) . . . *C. bruchivorus*
- Inter-tentorial distance 2.7–3.2 times greater than clypeus height (Fig. 4B); maxillary and labial palpomeres black basally, yellowish orange apically; (Fig. 11C) . . . *C. matilei*
- 9(7). Costa yellow; fore tibia entirely yellowish orange; (Fig. 11B) *C. riceorum* n. sp.
- Costa black; fore tibia entirely black, or mostly black with some yellowish orange in basal and/or apical sixths 10
- 10(9). Facial ridges parallel (as in Fig. 3B); second tergite with slightly elevated pinched-up area anteriorly (Fig. 9A); antenna with less than 46 flagellomeres; (Fig. 10A) *C. hunteri* n. sp.
- Facial ridges bowed outward (Fig. 2B); second tergite with strongly pinched-up area anteriorly (Fig. 9B); antenna with 48 to 53 flagellomeres; (Fig. 11D) . . . *C. rominus* n. sp.

SPECIES DESCRIPTIONS

Cyclaulacidea adairae Leathers n. sp.

Figs. 2A, 5C, 5D, 5E, 7B, 8A, 10D

Diagnosis.—Scape longer dorsally than ventrally (Fig. 5E). Rectangular bump on petiole narrowing posteriorly (Fig. 8A). Terga 1–3 black dorsally, yellowish orange laterally (Fig. 10D).

Length.—7.0–8.3 [8.0] mm.

Head.—Antenna with 42–45 [44] flagellomeres. Scape longer dorsally than ventrally. Scape lacking apical and pre-apical shelf-like process, [1.5]–2.0 times longer than maximally wide. First flagellomere 1.2–1.4 [1.3] times longer than second flagellomere, 1.3–[1.6] times longer than third flagellomere. Third flagellomere 1.0–1.3 [1.1] times longer than wide. Apical flagellomere 1.5–1.8 [1.6] times longer than wide. Flagellomere length equal to or greater than width. Horizontal length of eye 1.6–[2.2] times longer than length of head behind eye. Transverse diameter of posterior ocellus 0.9–1.5 [1.1] times post-ocellar length. Distance between posterior ocellus and eye 2.9–3.8 [3.5] times post-ocellar length. Longitudinal bump between antennal sockets present. Facial ridges bowed outward. Anterior groove between antennal sockets absent. Area between ridges filled in creating a raised median area. Median carina on face present, developed into raised tear-drop shaped

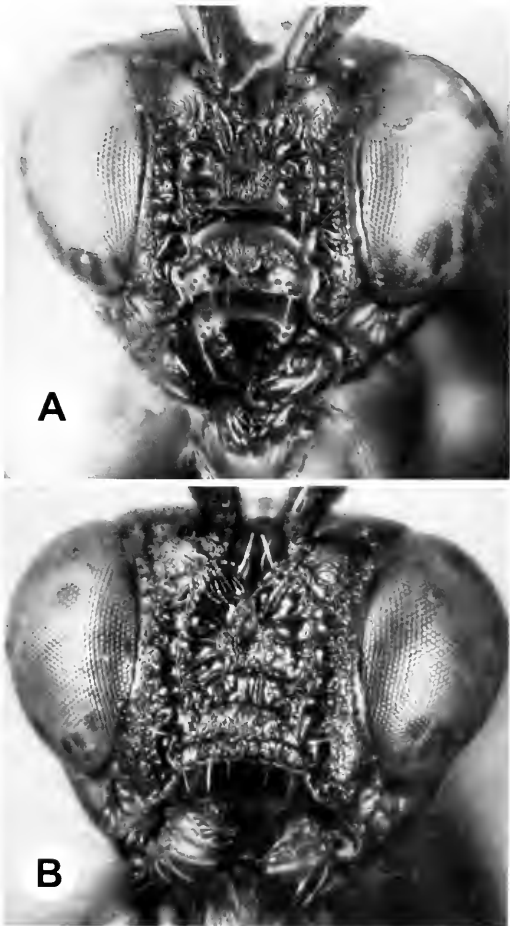


Fig. 2. Face of A) *C. adairae* (JL000100) and B) *C. rominus* (JL000228). Both have facial ridges that are bowed outward and a raised tear-drop shaped area in the center of the face.

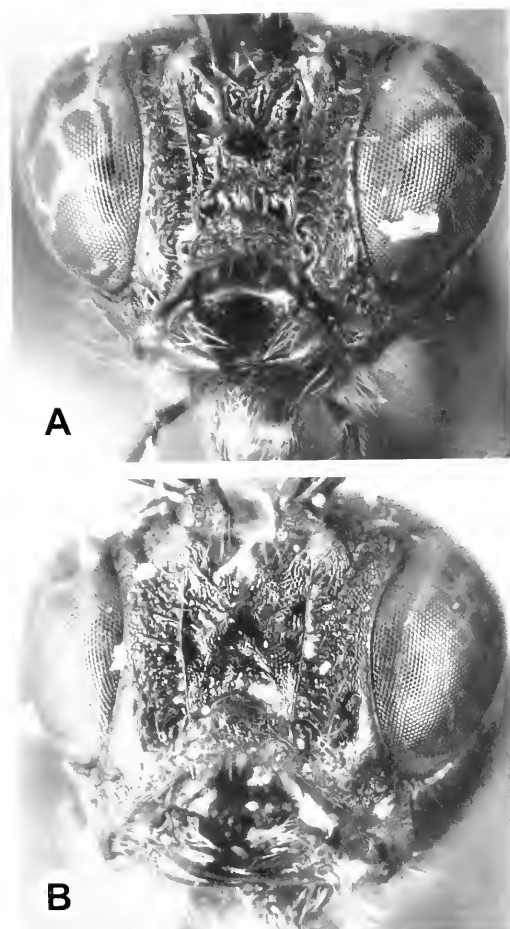


Fig. 3. Face of A) *C. snyderorum* (JL000101) with facial ridges that are diverging outward from the clypeus to the antennal sockets and B) *C. sharkeyi* (JL000203) with facial ridges that are more parallel. Both have raised chevron to butterfly-shaped areas in the center of the face.

area. Area between median carina and ridges with ladder-like series of horizontal carinae. Ridges running at 45° angle from middle ridge to antennal sockets strong. Groove around eyes present, [smooth] or crenulate. Eye height 1.2–[1.3] times greater than eye width, [1.2]–1.5 times greater than width of face. Width of head 2.2–2.8 [2.3] times greater than width of face. Inter-tentorial distance 2.0–2.4 [2.2] times clypeus height. Tentorio-ocular distance 0.8–[1.1] times clypeus height. Clypeus

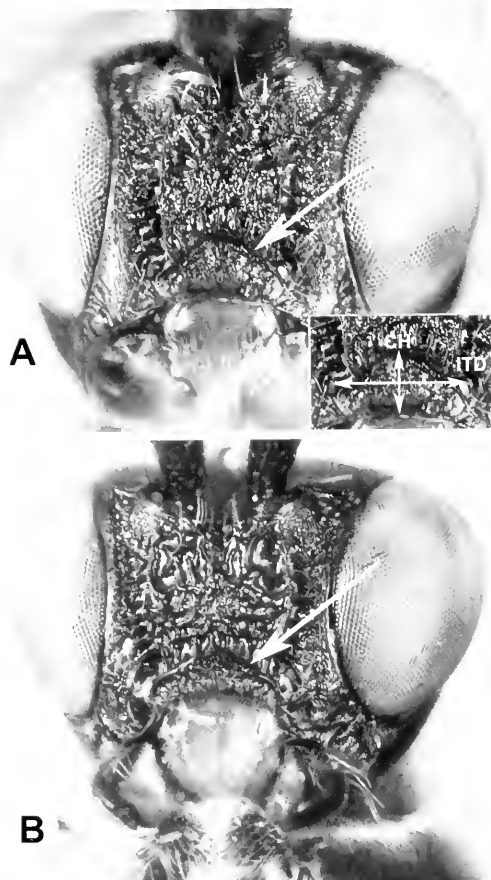


Fig. 4. Face of A) *C. bruchivorus* (JL000047) and B) *C. matilei* (JL000201). The arrow points to the clypeus, the shape of which can be used to distinguish between the two species. CH = clypeus height, ITD = inter-tentorial distance.

[partially filled in dorsally], or completely filled in but uneven. Ventral margin of clypeus concave. Area around clypeus with series of large crenulae and sharp ridge separating from rest of face, or [separated from rest of face by large smooth groove]. Face 0.9–1.2 [1.0] times wider than high. Malar suture paralleled by 2–[5] ridges. Malar space [0.2]–0.3 times eye height.

Mesosoma.—Mesosoma 1.3–1.5 [1.4] times longer than high. Pronotum with deep, smooth groove anteriorly. Notaulus not impressed. Border between mesoscutum and scutellum with weak carinate

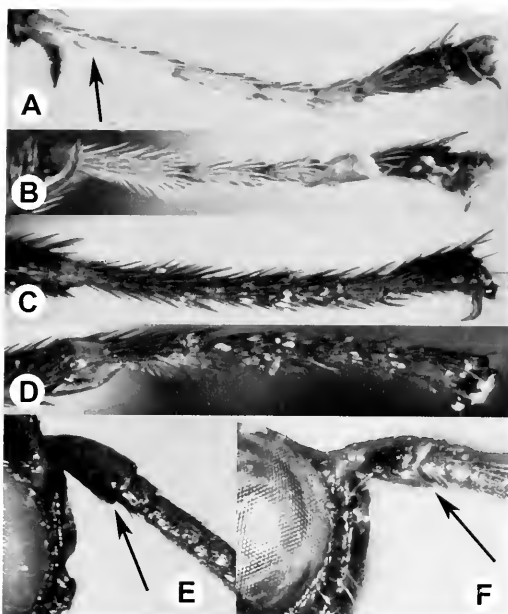


Fig. 5. A) Dorsal and B) lateral images of fore tarsus of *C. fergusonii* (JL000235) and C) dorsal and D) lateral images *C. adairae* (JL000102); arrow indicates relative lateral compression in fore tarsus of *C. fergusonii*. Scape of E) *C. adairae* (JL000102) and F) *C. snyderorum* (JL000107); arrow denotes ventral surface which is not longer than dorsal surface in *C. adairae* but is longer than dorsal surface in *C. snyderorum*.

groove, lacking strong median carina and enlarged median pit. Propodeal spiracle oval to [crescent-shaped], 2.5–3.3 [2.9] times higher than wide.

Fore tibia [1.1]–1.2 times longer than fore femur. Fore tarsus not laterally compressed, [1.5]–1.6 times longer than fore femur. Fore basitarsus [3.7]–5.0 times longer than wide, 1.6–[1.8] times longer than second tarsomere. Hind femur 3.8–4.2 [3.9] times longer than wide, 2.0–[2.4] times longer than basitarsus. Hind tibia 2.5–[2.9] times longer than basitarsus. Outer and inner hind tibial spurs 0.5–[0.6] and 0.6–[0.7] times longer than basitarsus, respectively. Hind basitarsus 3.4–4.1 [3.6] times longer than wide.

Fore wing venation: 1M and 1cu-a intersect. (RS+M)b broken apically. 1M 1.7–2.5 [2.0] times longer than 1RS. 2M 3.5–4.1 [3.6] times longer than r-m. 1m-cu 1.2–1.6

[1.4] times longer than r, 1.5–2.2 [1.6] times as thick as (RS+M)a. 2RS [1.3]–1.5 times longer than r-m. 3RSa [3.0]–3.4 times longer than r-m, 4.6–6.2 [5.3] times longer than r. 3RSb 6.0–7.6 [7.1] times longer than r. C+SC+R and 1RS forming an angle of 67–73° [71°]. Fore wing length 6.9–8.0 [7.9] mm.

Hind wing vein R1a [1.3]–1.8 times longer than 1r-m.

Metasoma.—Base of petiole deeply excavated. First tergite with strongly raised rectangular bump. First tergite with lateral carina closely paralleling median bump but not forming notches, with pair of lateral carinae entirely separated from median bump. First tergite [0.9]–1.1 times longer than wide. Border between first and second tergite straight with edges curving anteriorly. Second median tergite with strongly pinched-up area not reaching third tergite. Suturiform articulation with weak, smooth, M-shaped, weakly arched groove; with carina present along anterior margin. Second tergite [0.4]–0.5 times longer than wide, [0.7]–0.9 times longer than third tergite. Third tergite [0.5]–0.6 times longer than wide. Hypopygium with convex dorsal margin. Ovipositor 0.8–[1.0] times body length.

Color.—Entirely black except lateral parts of terga 1–3 yellowish orange and sometimes apical parts of mid and hind trochantellus yellowish orange or red. Wings entirely black.

Distribution and material examined.—Known from Guanacaste, Alajuela, and Heredia provinces of Costa Rica. 7♀ 1♂ examined.

Holotype ♀. COSTA RICA: Guanacaste: 3km SE R. Naranjo, 3–8.iii.1992, F.D. Parker (EMUS—JL000100). **Paratypes**. COSTA RICA: Guanacaste: 3km SE R. Naranjo: 2♀, 3–8.iii.1992, F.D. Parker (EMUS—JL000102, 000105); 1♀, 28.xi–5.xii.1991, F.D. Parker (EMUS—JL000103); 1♂, xii.1991, F.D. Parker (EMUS—JL000106). Alajuela: 2♀, 20.xi.1990, F.D. Parker (EMUS—JL000231, 000232). Heredia: F. La Selva, 3km S. Pto. Viejo: 1♀, 14.iii.1980, H.A. Hespeneheide (ESUW—JL000233).

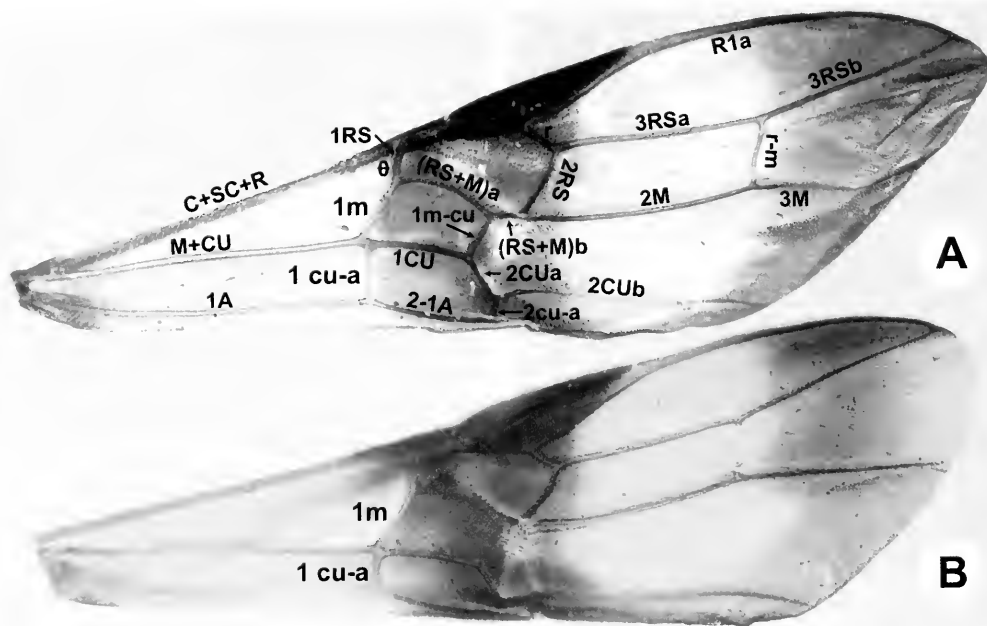


Fig. 6. Fore wing of A) *C. bruchivorus* (JL000246) and B) *C. riccorum* (JL000162). θ = the angle of Fore wing veins C+SC+R and 1RS.

Remarks.—Coloration appears almost identical to *C. snyderorum* sp. n., but can be consistently distinguished using the diagnostic characters in the key.

Etymology.—For Lila Adair for her support of science education at Central Gwinnett High School.

***Cyclaulacidea fergusonii* Leathers n. sp.**

Figs. 5A, 5B, 7A, 10B

Diagnosis.—Suturiform articulation with deep groove (Fig. 7A). Facial ridges bowed inward. Terga 4–6 black dorsally, yellowish orange laterally (Fig. 10B).

Length.—8.6 mm.

Head.—Antenna with 46 flagellomeres. Scape longer ventrally than dorsally. Scape with shelf-like process apically, lacking pre-apical shelf, 2.1 times longer than maximally wide. First flagellomere 1.4 times longer than second flagellomere, 1.5 times longer than third flagellomere. Third flagellomere 1.5 times longer than wide. Apical flagellomere 1.8 times longer than wide. Flagellomere

length equal to or greater than width. Horizontal length of eye 1.6 times longer than length of head behind eye. Transverse diameter of posterior ocellus 0.8 times post-ocular length. Distance between posterior ocellus and eye 2.6 times post-ocular length. Longitudinal bump between antennal sockets absent. Facial ridges bowed inward. Deep anterior groove between antennal sockets absent. Area between ridges filled in creating a raised median area. Median carina on face present, developed into raised tear-drop shaped area. Area between median carina and ridges with ladder-like series of horizontal carinae. Ridges running at 45° angle from middle ridge to antennal sockets strong. Groove around eyes present and smooth. Height of eye 1.2 times greater than eye width and 1.5 times greater than width of face. Width of head 2.6 times greater than width of face. Intertentorial distance 2.4 times clypeus height. Tentorio-ocular distance 0.9 times longer than clypeus high. Clypeus com-

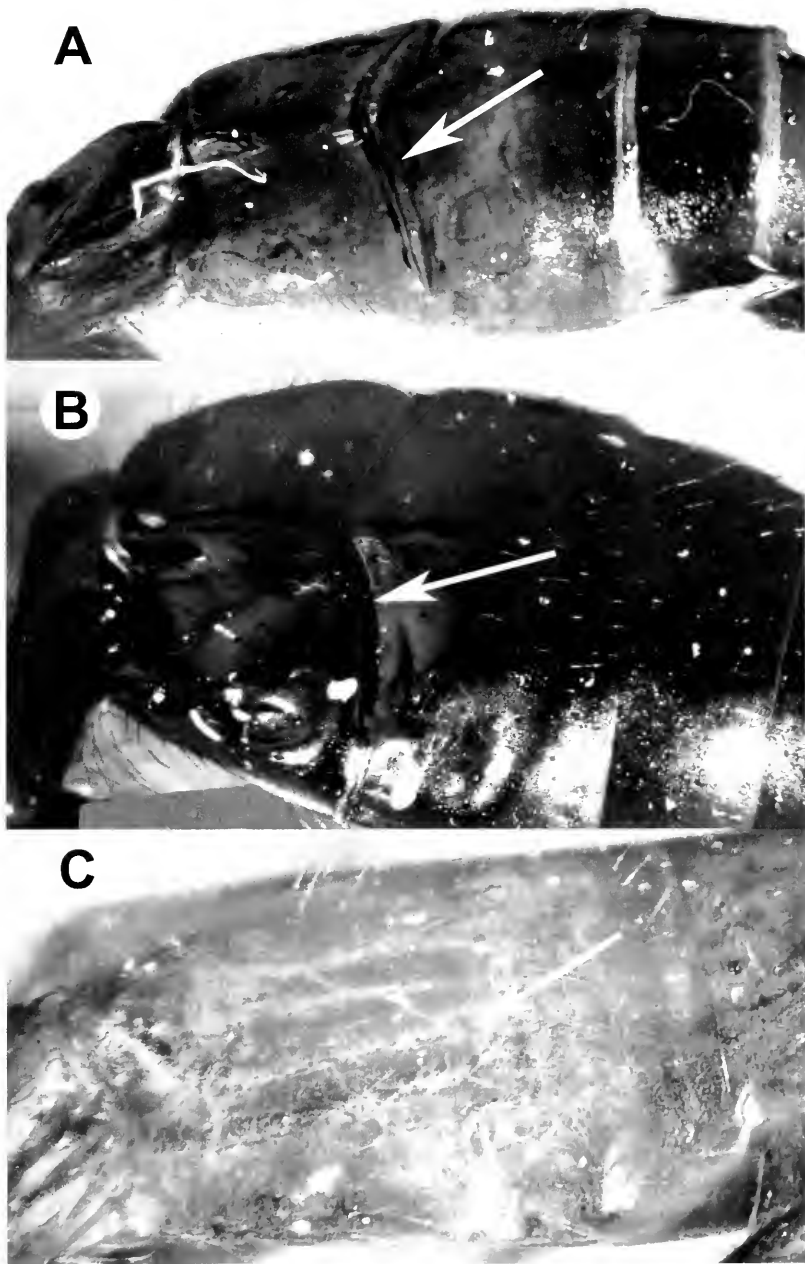


Fig. 7. Metasomal syntergite 2+3 with A) deep groove on *C. fergusonii* (JL000235), B) shallow groove on *C. adairae* (JL000102), C) lack of groove on *C. picki* (JL000202). Arrow indicates suturiform articulation.

pletely filled in but uneven. Ventral margin of clypeus concave. Area around clypeus with series of large crenulae and sharp ridge separating from rest of face. Face 0.9 times wider than high. Malar su-

ture paralleled by 6 ridges. Malar space 0.2 times eye height.

Mesosoma.—Mesosoma 1.6 times longer than high. Pronotum with deep, smooth groove anteriorly. Notaulus weakly im-

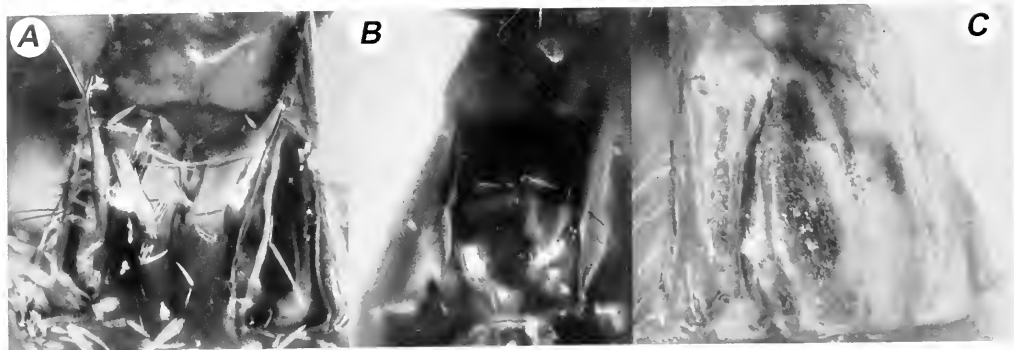


Fig. 8. First tergite of A) *C. adairae* (JL000232) with rectangular bump narrowing posteriorly, B) *C. snyderorum* (JL000107) with rectangular bump, and C) *C. picki* (JL000202) with tongue-shaped bump.

pressed. Border between mesoscutum and scutellum with carinate groove, lacking median carina and enlarged median pit. Propodeal spiracle crescent-shaped, 2.3 times higher than wide.

Fore tibia 1.0 times the length of fore femur. Fore tarsus strongly laterally compressed, 1.6 times longer than fore femur. Fore basitarsus 4.7 times longer than wide, 2.0 times longer than second tarsomere. Hind femur 4.0 times longer than wide, 1.9 times longer than basitarsus. Hind tibia 2.7 times longer than basitarsus. Outer and inner hind tibial spurs 0.4 and 0.6 times longer than basitarsus, respectively. Hind basitarsus 4.6 times longer than wide.

Fore wing venation: 1M and 1cu-a intersect. (RS+M)b broken apically. 1M 2.4 times longer than 1RS. 2M 4.2 times longer than r-m. 1m-cu 1.3 times longer than r, 1.5 times as thick as (RS+M)a. 2RS 1.5 times longer than r-m. 3RSa 3.3 times longer than r-m, 4.8 times longer than r. 3RSb 5.8 times longer than r. C+SC+R and 1RS forming an angle of 67°. Fore wing length 7.8 mm.

Hind wing vein R1a 1.4 times longer than 1r-m.

Metasoma.—Base of petiole deeply excavated. First tergite with strongly raised rectangular bump. First tergite with lateral carina closely paralleling median bump but not forming notches, with pair of lat-

eral carina entirely separated from median bump. First tergite 0.8 times longer than wide. Border between first and second tergite straight with edges curving anteriorly. Second tergite with strongly pinched-up area not reaching third tergite. Suturiform articulation with deep, smooth, M-shaped, weakly arched groove; carina along anterior margin present. Second tergite 0.5 times longer than wide, 0.7 times longer than third tergite. Third tergite 0.7 times longer than wide.

Color.—Black except as follows: mouthparts white, pronotum with yellowish orange stripe on ventral third, fore tarsus and mid tarsus yellowish orange with telotarsus black, hind trochantellus mostly black with some red apically, tergum 1 yellowish orange laterally, terga 2 and 3 reddish orange, terga 4–6 yellowish orange laterally. Wings entirely black.

Distribution and material examined.—Known only from type specimen. 1♂ examined.

Holotype ♂. PANAMA: N. Panama, 1050m, Fortuna, Chiriquí, 22–28.v.1979, H. Wolda (RMNH—JL000235).

Etymology.—For George Ferguson for his generous support of this project and systematic entomology at Oregon State University.

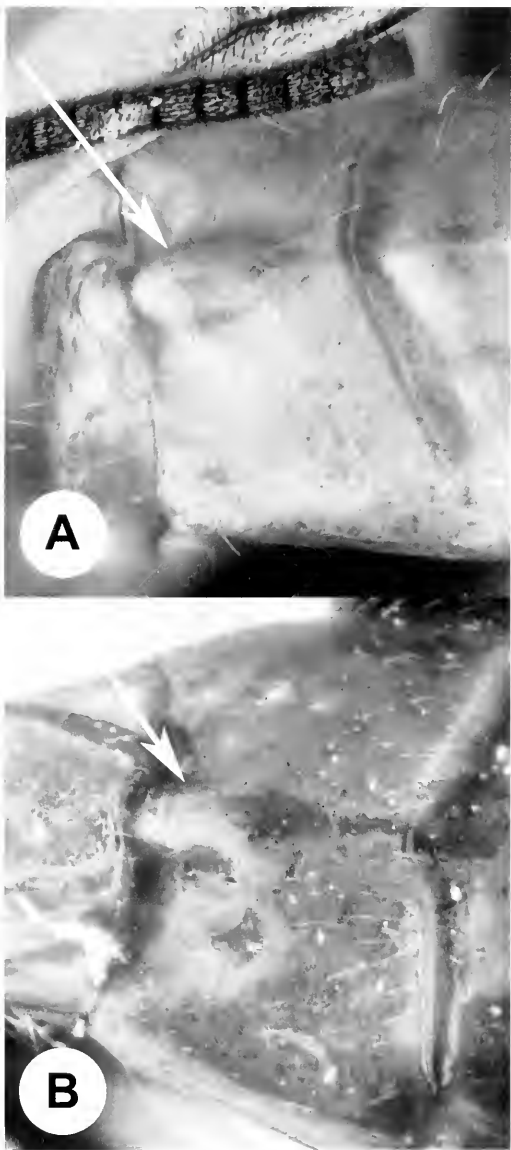


Fig. 9. Second tergite of A) *C. hunteri* (JL000110) and B) *C. rominus* (JL000228). Arrow denotes pinched-up areas.

Cyclaulacidea hunteri Leathers n. sp.

Figs. 9A, 10A

Diagnosis.—Fore wing banded: clear, black, clear, black (Fig. 10A). Maxillary and labial palpomeres white. Horizontal length of eye (in dorsal view) 1.5 times longer than length of head behind eye. Antenna with 42 flagellomeres.

Length.— [7.0]–7.5 mm.

Head.—Antenna with 42 flagellomeres. Scape longer ventrally than dorsally. Scape with shelf-like process apically, lacking pre-apical shelf. Scape [1.8]–2.1 times longer than maximally wide. First flagellomere [1.3]–1.4 times longer than second flagellomere, [1.4]–1.5 times longer than third flagellomere. Third flagellomere 1.1 times longer than wide. Apical flagellomere [1.6] times longer than wide. Flagellomere length equal to or greater than width. Horizontal length of eye 1.5 times longer than length of head behind eye. Transverse diameter of posterior ocellus 1.0–[1.2] times post-ocellar length. Distance between posterior ocellus and eye 3.9–[4.9] times post-ocellar length. Facial ridges parallel. Anterior groove between antennal sockets very weak. Area between ridges filled in creating a raised median area. Median carina on face present, developed into raised tear-drop shaped area. Area between median carina and ridges with ladder-like series of horizontal carinae. Ridges running at 45° angle from middle ridge to antennal sockets strong. Groove around eyes present and crenulate. Eye height [1.3]–1.4 times greater than eye width, 1.4 times greater than width of face. Width of head 2.4 times greater than width of face. Inter-tentorial distance [2.2]–2.3 times clypeus height. Tentorio-ocular distance 1.1 times longer than clypeus high. Clypeus partially filled in dorsally. Ventral margin of clypeus concave. Area around clypeus with series of large crenulae and sharp ridge separating from rest of face. Face [0.9]–1.0 times wider than high. Malar suture paralleled by 2 ridges. Malar space 0.1–[0.2] times eye height.

Mesosoma.—Mesosoma 1.4 times longer than high. Pronotum with deep, smooth groove anteriorly. Notaulus not impressed. Border between mesoscutum and scutellum with carinate groove, lacking median carina or enlarged median pit; median part of groove sometimes filled in.



Fig. 10. Automontage® lateral images of A) *C. hunteri* (JL000110), B) *C. fergusonii* (JL000235), C) *C. snyderorum* (JL000101), and D) *C. adairae* (JL000105). Ovipositor sheaths were removed from A. Magnification = 7.2×.

Propodeal spiracle oval, 2.0–[2.2] times higher than wide.

Fore tibia 1.1 times longer than fore femur. Fore tarsus not laterally compressed,

1.6 times longer than fore femur. Fore basitarsus [4.2]–4.8 times longer than wide, [1.6]–1.7 times longer than second tarsomere. Hind femur 3.6–[4.0] times longer

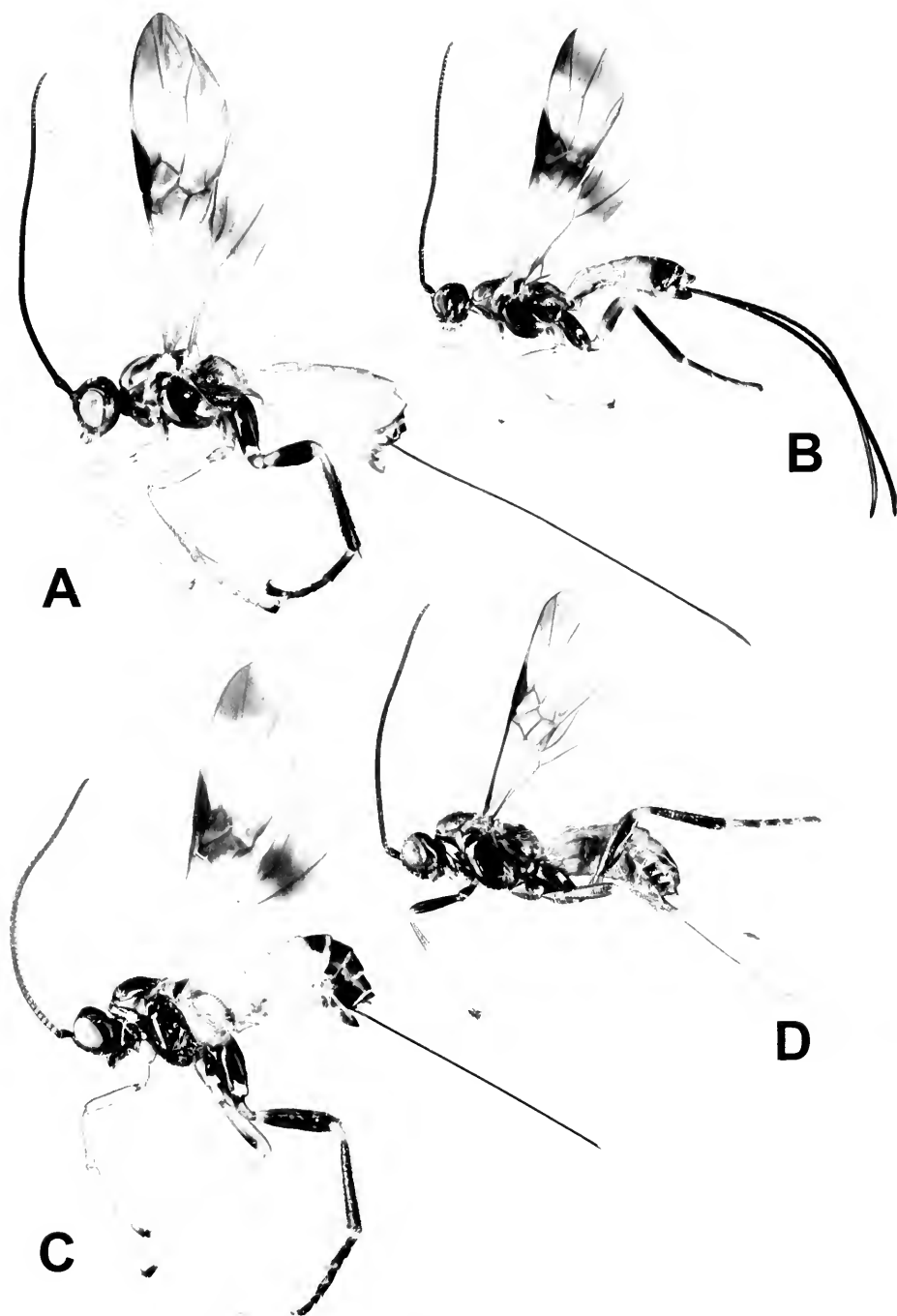


Fig. 11. Automontage® lateral images of A) *C. bruchivorus* (JL000246), B) *C. riccorum* (JL000162), C) *C. matilei* (JL000201), and D) *C. rominus* (JL000228). Ovipositor sheaths were removed from A, C, and D. Magnification = 4.7 \times .

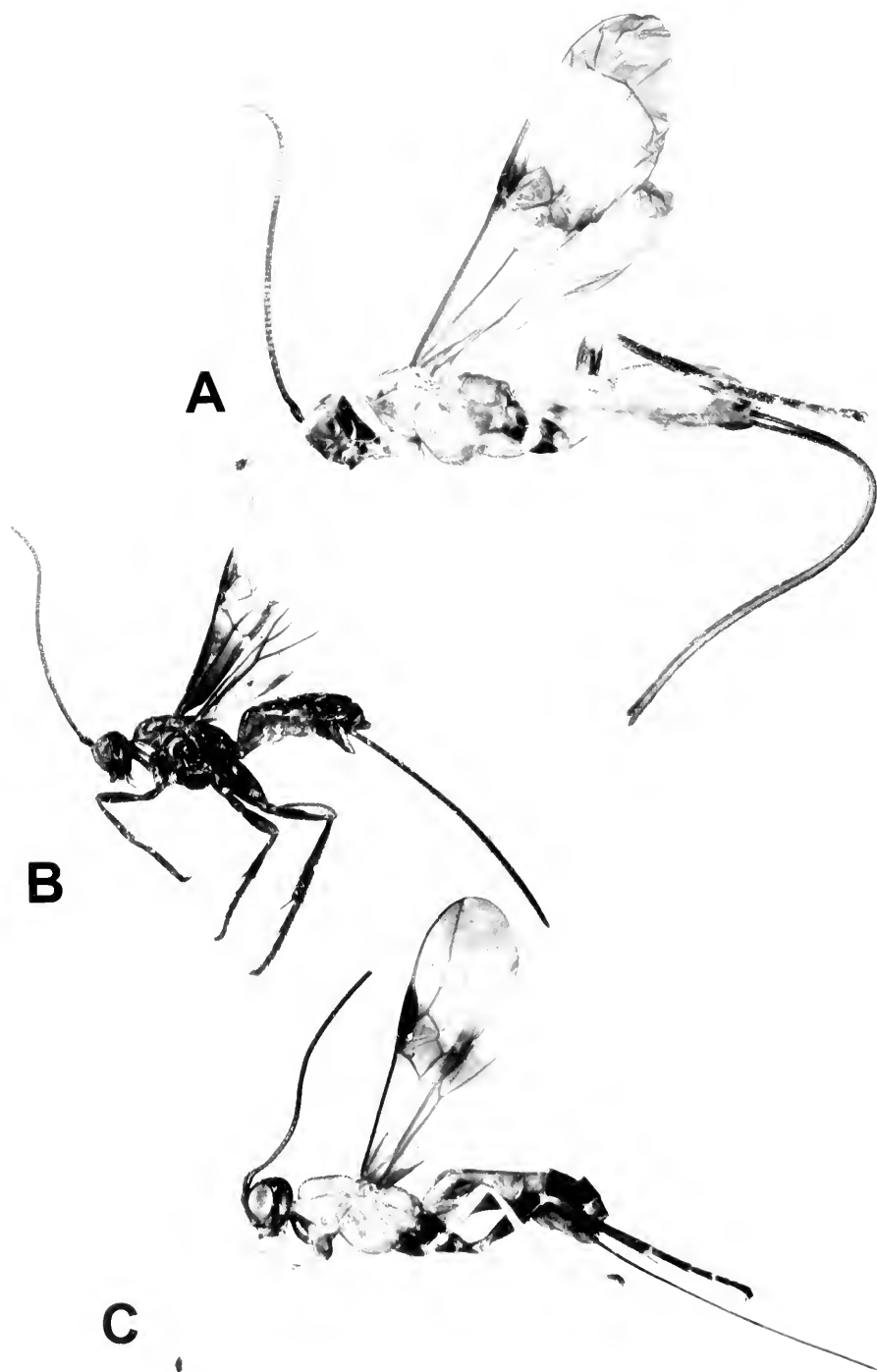


Fig. 12. Automontage[®] lateral images of A) *C. sharkeyi* (JL000236), B) *C. pottsae* (JL000243), and C) *C. picki* (JL000202). Ovipositor sheaths were removed from B and C. Magnification = 5.1 \times .

than wide, 1.8–[2.7] times longer than basitarsus. Hind tibia 2.4–[2.7] times longer than basitarsus. Outer and inner hind tibial spurs 0.5 and 0.7 times length of basitarsus, respectively. Hind basitarsus 4.0–[4.7] times longer than wide.

Fore wing venation: 1M and 1cu-a intersect. (RS+M)b broken apically. 1M 1.9–[2.0] times longer than 1RS. 2M 3.4–[3.5] times longer than r-m. 1m-cu 1.1–[1.2] times longer than r, [1.2]–1.4 times as thick as (RS+M)a. 2RS 1.1–[1.2] times longer than r-m. 3RSa 3.0 times longer than r-m, 4.8–[5.3] times longer than r. 3RSb 5.1–[5.5] times longer than r. C+SC+R and 1RS forming an angle of 72°. Fore wing length [7.0]–7.5 mm.

Hind wing vein R1a [1.5]–1.6 times longer than 1r-m.

Metasoma.—Base of petiole deeply excavated. First tergite with strongly raised rectangular bump. First tergite with lateral carina closely paralleling median bump but not forming notches, lacking pair of lateral carina entirely separated from median bump. First tergite [0.8]–0.9 times longer than wide. Border between first and second tergite straight with edges curving anteriorly. Second tergite smooth, with slightly elevated pinched-up area anteriorly. Suturiform articulation with weak, smooth, V-shaped, weakly arched groove; with carina present along anterior margin. Second tergite [0.4]–0.5 times longer than wide, [0.8]–0.9 times longer than third tergite. Third tergite [0.5]–0.6 times longer than wide. Hypopygium with convex dorsal margin. Ovipositor 1.1–[1.2] times body length.

Color.—Black except as follows: maxillary and labial palpomeres white, metanotum sometimes yellowish orange, propodeum yellowish orange, fore tarsus yellowish orange but telotarsus black, terga 1–4 yellowish orange. Fore wing banded clear, black, clear, black; hind wing yellow in basal half, black apically.

Distribution and material examined.—Known only from type locality in the Al-

ajuela province of Costa Rica. 2♀♀ examined.

Holotype ♀. COSTA RICA: Alajuela: 20km S. Upala, 22–31.x.1991, F.D. Parker (EMUS—JL000109).

Paratype. 1♀, COSTA RICA: Alajuela: 20km S. Upala, 16.x.1990, F.D. Parker (EMUS—JL000110).

Etymology.—For Mark D. Hunter of The University of Georgia.

Cyclaulacidea picki Leathers n. sp.

Figs. 7C, 8C, 12C

Diagnosis.—Suturiform articulation barely distinguished from remainder of metasomal syntergum 2+3 (Fig. 7C). Strongly raised bump on petiole tongue-shaped (Fig. 8C). Median ridge on face developed into tear-drop shaped area (as in Figs 2A, 2B).

Length.—10.3 mm.

Head.—Antenna broken after 46th flagellomere. Scape longer ventrally than dorsally. Scape with shelf-like process apically, lacking pre-apical shelf, 1.8 times longer than maximally wide. First flagellomere 1.3 times longer than second flagellomere and 1.3 times longer than third flagellomere. Third flagellomere 1.5 times longer than wide. Flagellomere length equal to or greater than width. Horizontal length of eye 0.9 times longer than length of head behind eye. Transverse diameter of posterior ocellus 1.6 times post-ocellar length. Distance between posterior ocellus and eye 5.3 times post-ocellar length. Longitudinal bump between antennal sockets present. Facial ridges bowed outward. Deep anterior groove between antennal sockets absent. Area between ridges not filled in, level with rest of face. Median carina on face present, developed into raised tear-drop shaped area. Area between median carina and ridges with ladder-like series of horizontal carinae. Ridges running at 45° angle from middle ridge to antennal sockets strong. Groove around eyes present and smooth. Eye height 1.3 times greater than eye width, 1.3 times greater than width of face. Width of head 2.4 times greater than

width of face. Inter-tentorial distance 2.5 times clypeus height. Tentorio-ocular distance 1.1 times longer than clypeus high. Clypeus partially filled in dorsally. Ventral margin of clypeus concave. Area around clypeus not differentiated from rest of face. Face 1.0 times wider than high. Malar suture paralleled by 8 ridges. Malar space 0.2 times eye height.

Mesosoma.—*Mesosoma* 1.6 times longer than high. Pronotum with weak groove anteriorly. Notaulus not impressed. Border between mesoscutum and scutellum with carinate groove, lacking median carina and enlarged median pit. Propodeal spiracle crescent-shaped, 1.9 times higher than wide.

Fore tibia 1.1 times longer than fore femur. Fore tarsus not laterally compressed, 1.7 times longer than fore femur. Fore basitarsus 5.2 times longer than wide, 1.7 times longer than second tarsomere. Hind femur 4.1 times longer than wide, 1.5 times longer than basitarsus. Hind tibia 2.6 times longer than basitarsus. Outer and inner hind tibial spurs 0.3 and 0.5 times longer than basitarsus, respectively. Hind basitarsus 5.5 times longer than wide.

Fore wing venation: 1M and 1cu-a intersect. (RS+M)b broken apically. 1M 2.3 times longer than 1RS. 2M 3.5 times longer than r-m. 1m-cu 1.3 times longer than r, 1.7 times as thick as (RS+M)a. 2RS 1.2 times longer than r-m. 3RSa 2.9 times longer than r-m, 4.8 times longer than r. 3RSb 5.4 times longer than r. C+SC+R and 1RS forming an angle of 71°. Fore wing length 9.0 mm.

Hind wing vein R1a 1.8 times longer than 1r-m.

Metasoma.—Base of petiole deeply excavated. First tergite with strongly raised tongue-shaped bump. First tergite lacking lateral carina adjacent to median bump, with pair of lateral carina entirely separated from median bump. First tergite 1.1 times longer than wide. Border between first and second tergite straight with edges

curving anteriorly. Second tergite smooth, with slightly elevated pinched-up area anteriorly. Sutureform articulation barely distinguished from remainder of syntergite, lacking groove, M-shaped, weakly arched; lacking carina along anterior margin. Second tergite 0.7 times longer than wide 1.4 times longer than third tergite. Third tergite 0.5 times longer than wide. Hypopygium with convex dorsal border. Ovipositor 1.1 times body length.

Color.—Yellowish orange and black. Head black with maxillary and labial palpomeres yellowish orange.

Mesosoma yellowish orange except propleuron black. Fore and mid legs yellowish orange except both coxae black and tarsi yellowish orange with telotarsus black. Hind leg black except some yellowish orange on basal part of tibia. Fore wing banded: black, yellow, black, yellow, black, costa black. Hind wing banded: yellow, black, clear.

Terga 1–4 yellowish orange. Terga 5–8 and ovipositor sheath black.

Distribution and material examined.—Known only from type specimen. 1♀ examined.

Holotype ♀. SURINAME: Suriname Exp. 1948–1949, Nassau Mts., Malowijne, 15.ii.1949, D.C. Geijskes (RMNH—JL000202).

Remarks.—This species is very strange and may not be a member of *Cyclaulacidea*. Although it has the tear-drop shaped median area of the face, a putative synapomorphy for *Cyclaulacidea*, it lacks the well-developed sutureform articulation and rectangular bump on the first tergite that all other species of *Cyclaulacidea* possess.

Etymology.—For John Pickering of The University of Georgia.

Cyclaulacidea pottsae Leathers n. sp.

Fig. 12B

Diagnosis.—Fore wing black with one clear stripe. Hind wing black with clear apical tip. Terga 1–7 black dorsally, reddish orange laterally (Fig. 12B).

Length.—8.0 mm.

Head.—Antenna with 46 flagellomeres. Scape longer ventrally than dorsally. Scape with shelf-like process apically, lacking pre-apical shelf, 1.5 times longer than maximally wide. First flagellomere 1.4 times longer than second flagellomere, 1.5 times longer than third flagellomere. Third flagellomere 1.1 times longer than wide. Apical flagellomere 1.7 times longer than wide. Flagellomere length equal to or greater than width. Horizontal length of eye 1.5 times longer than length of head behind eye. Transverse diameter of posterior ocellus 0.8 times post-ocellar length. Shortest distance between posterior ocellus and eye 2.9 times post-ocellar length. Longitudinal bump between antennal sockets present. Facial ridges diverging outward straight from clypeus to antennal sockets. Deep anterior groove between antennal sockets absent. Area between ridges not filled in, level with rest of face. Median carina on face present, developed into raised tear-drop shaped area. Area between median carina and ridges with ladder-like series of horizontal carinae. Ridges running at 45° angle from middle ridge to antennal sockets strong. Groove around eyes present and crenulate. Eye height 1.3 times greater than eye width, 1.2 times greater than width of face. Width of head 2.3 times greater than width of face. Inter-tentorial distance 2.5 times clypeus height. Tentorio-ocular distance 1.3 times longer than clypeus high. Clypeus completely filled in but uneven. Ventral margin of clypeus concave. Area around clypeus with series of large crenulae and sharp ridge separating from rest of face. Face 1.1 times wider than high. Malar suture paralleled by 4 ridges. Malar space 0.2 times eye height.

Mesosoma.—Mesosoma 1.5 times longer than high. Pronotum with deep, smooth groove anteriorly. Notaulus not impressed. Border between mesoscutum and scutellum with carinate groove, lacking median carina and median area not en-

larged into a median pit. Propodeal spiracle oval, 2.0 times higher than wide.

Fore tibia 1.2 times longer than fore femur. Fore tarsus not laterally compressed, 1.6 times longer than fore femur. Fore basitarsus 4.2 times longer than wide, 1.8 times longer than second tarsomere. Hind femur 3.8 times longer than wide, 1.8 times longer than basitarsus. Hind tibia 2.6 times longer than basitarsus. Outer and inner hind tibial spurs 0.4 and 0.6 times longer than basitarsus, respectively. Hind basitarsus 5.5 times longer than wide.

Fore wing venation: 1M and 1cu-a intersect. (RS+M)b broken apically. 1M 2.1 times longer than 1RS. 2M 3.6 times longer than r-m. 1m-cu 1.1 times longer than r, 1.8 times as thick as (RS+M)a. 2RS 1.1 times length of r-m. 3RSa 3.2 times longer than r-m, 5.1 times longer than r. 3RSb 4.7 times longer than r. C+SC+R and 1RS forming an angle of 78°. Fore wing length 7.6 mm.

Hind wing vein R1a 1.5 times longer than 1r-m.

Metasoma.—Base of petiole deeply excavated. First tergite with strongly raised rectangular bump. First tergite with lateral carina closely paralleling median bump but not forming notches, lacking pair of lateral carina entirely separated from median bump. First tergite 0.9 times longer than wide. Border between first and second tergite straight with edges curving anteriorly. Second tergite with strongly pinched-up area not reaching third tergite. Suturiform articulation with weak, smooth, M-shaped, weakly arched groove; with carina present along anterior margin. Second tergite 0.5 times longer than wide, 0.7 times longer than third tergite. Third tergite 0.6 times longer than wide. Hypopygium with flat dorsal border. Ovipositor 1.0 times body length.

Color.—Mostly black except maxillary and labial palpomeres yellowish orange apically, margins of eyes yellowish orange, and terga 1–7 reddish orange later-

ally. Fore wing black with one clear stripe. Hind wing black with clear apical tip.

Distribution and material examined.—Known only from type specimen. 1 ♀ examined.

Holotype ♀. MEXICO: Orizaba, 1867, O. Sichel, (MNHN—JL000243).

Etymology.—For Martha Potts of The University of Kentucky.

***Cyclaulacidea riceorum* Leathers n. sp.**

Figs. 6B, 11B

Diagnosis.—Fore wing veins 1M and 1cu-a intersect. Hind tarsus black but basal part of basitarsus orange. Ovipositor 1.2 times body length. Horizontal length of eye (in dorsal view) 1.0–1.4 times longer than length of head behind eye. Fore tibia entirely yellowish orange (Fig. 11B).

Length.—7.8–[10.1] mm.

Head.—Antenna with 48–[52] flagellomeres. Scape longer ventrally than dorsally, with shelf-like process apically, lacking pre-apical shelf, 1.7–[2.1] times longer than maximally wide. First flagellomere 1.3–1.5 [1.4] times longer than second flagellomere and 1.4–[1.6] times longer than third flagellomere. Third flagellomere [1.2]–1.3 times longer than wide. Apical flagellomere [1.8]–2.9 times longer than wide. Flagellomere length equal to or greater than width. Horizontal length of eye [1.0]–1.4 times longer than length of head behind eye. Transverse diameter of posterior ocellus 0.9–[1.2] times post-ocellar length. Shortest distance between posterior ocellus and eye 2.8–[4.0] times post-ocellar length. Longitudinal bump between antennal sockets present. Facial ridges parallel. Deep anterior groove between antennal sockets very weak. Area between ridges not filled in, level with rest of face, or filled in creating a raised median area. Median carina on face present, developed into raised tear-drop shaped area. Area between median carina and ridges with ladder-like series of horizontal carinae. Ridges running at 45° angle from

middle ridge to antennal sockets strong. Groove around eyes present and crenulate. Eye height [1.3]–1.4 times greater than eye width, 1.2–1.7 [1.3] times greater than width of face. Width of head 2.1–2.7 [2.2] times greater than width of face. Inter-tentorial distance 1.9–3.1 [2.0] times clypeus height. Tentorio-ocular distance 0.7–1.1 [0.9] times longer than clypeus high. Clypeus partially filled in dorsally. Ventral margin of clypeus concave. Area around clypeus with series of large crenulae but lacking ridge, or [with series of large crenulae and sharp ridge separating from rest of face]. Face 0.7–1.1 [0.8] times wider than high. Malar suture paralleled by 1–4 [3] ridges. Malar space 0.1–[0.2] times eye height.

Mesosoma.—Mesosoma 1.6–[1.7] times longer than high. Pronotum with deep, smooth groove anteriorly. Notaulus not impressed. Border between mesoscutum and scutellum with carinate groove. Border between mesoscutum and scutellum lacking median carina and enlarged median pit. Propodeal spiracle [oval] to crescent-shaped, 2.0–2.5 [2.2] times higher than wide.

Fore tibia 1.1–[1.2] times longer than fore femur. Fore tarsus not laterally compressed, [1.6]–1.7 times longer than fore femur. Fore basitarsus 4.3–5.4 [5.2] times longer than wide, 1.5–1.8 [1.6] times longer than second tarsomere. Hind femur 3.8–[4.0] times longer than wide, [1.6]–1.8 times longer than basitarsus. Hind tibia [2.3]–2.7 times longer than basitarsus. Outer and inner hind tibial spurs [0.4]–0.5 and 0.6 times longer than basitarsus, respectively. Hind basitarsus 5.0–6.2 [6.0] times longer than wide.

Fore wing venation: 1M and 1cu-a intersect. (RS+M)b broken apically. 1M 1.9–2.1 [2.0] times longer than 1RS. 2M 3.3–[3.8] times longer than r-m. 1m-cu 1.0–1.5 [1.2] times longer than r, 1.1–2.2 [1.5] times as thick as (RS+M)a. 2RS 1.2–[1.3] times longer than r-m. 3RSa 2.7–[3.2] times longer than r-m, 4.3–6.2 [5.0] times longer

than r. 3RSb [5.2]–7.2 times longer than r. C+SC+R and 1RS forming an angle of 72–78° [74°]. Fore wing length 7.3–[8.6] mm.

Hind wing vein R1a [1.4]–1.6 times longer than 1r-m.

Metasoma.—Base of petiole deeply excavated. First tergite with strongly raised rectangular bump. First tergite with lateral carina closely paralleling median bump but not forming notches, lacking pair of lateral carina entirely separated from median bump. First tergite 0.8–1.1 [1.0] times longer than wide. Border between first and second tergite straight with edges curving anteriorly. Second tergite smooth, with slightly elevated pinched-up area anteriorly. Suturiform articulation with weak, smooth, V-shaped, weakly arched groove; with carina along anterior margin. Second tergite [0.5]–0.6 times longer than wide, 0.7–0.9 [0.8] times longer than third tergite. Third tergite 0.6–[0.7] times longer than wide. Hypopygium with convex dorsal border. Ovipositor 1.2 times body length.

Color.—Black and yellow. Head black except maxillary and labial palpomeres and sometimes areas around margins of eyes and posterior to malar suture yellowish orange.

Mesosoma black except sometimes dorsal parts of propodeum yellowish orange. Forecoxa, trochanter, trochantellus, and femur black or yellowish orange. Fore tibia yellowish orange. Fore tarsus yellowish orange but telotarsus black. Mid coxa black, or yellowish orange, or mostly yellowish orange with some black basally. Mid trochanter black, or yellowish orange. Mid trochantellus yellowish orange. Mid femur black, or yellowish orange, or mostly black, with some yellowish orange on both ends. Mid tibia yellowish orange, or yellowish orange but black in apical quarter. Mid tarsus mostly yellowish orange but telotarsus black. Hind coxa and trochanter black. Hind trochantellus yellowish orange. Hind femur black, or black in apical half, yellowish orange basally, or

mostly black with some yellowish orange by trochanter. Hind tibia black, or mostly black but yellowish orange basally. Hind tarsus black but basal part of basitarsus orange. Fore wing banded: yellow, black, yellow, black, costa yellow. Hind wing yellow in basal half, black apically, or banded: yellow, black, yellow.

Terga 1–3 yellowish orange. Tergum 4 yellowish orange anteriorly, black posteriorly. Tergum 5 black, or yellowish orange anteriorly, black posteriorly. Terga 6–8 and ovipositor sheath black.

Distribution and material examined.—Known from Peru and Brazil. 2♀♀, 4♂♂ examined.

Holotype ♀. PERU: Madre de Dios: Rio Tambopata Reserve, 30km (air) SW Puerto Maldonado, 290m, 25–30.iv.1984, W.J. Pulawski (CAS—JL000094).

Paratypes. PERU: 1♀, Madre de Dios: Rio Tambopata Reserve, 30km (air) SW Puerto Maldonado, 290m, 25–30.iv.1984, W.J. Pulawski (CAS—JL000162); Monzon Valley, Tingo Maria, E.I. Schlinger & E.S. Ross: 1♂ 2.xi.1954 (CAS—JL000240), 1♂ 19.x.1954 (CAS—JL000241), 1♂ 3.xi.1954 (CAS—JL000242). BRAZIL: 1♂, Utiariti (325m), Rio Papagaio, viii.1961, K. Lenko (MZSP—JL000244).

Etymology.—For Harold and Leona Rice for their generous support of this research and systematic entomology at Oregon State University.

***Cyclaulacidea rominus* Leathers n. sp.**

Figs. 2B, 11D

Diagnosis.—Fore wing banded yellow, black, yellow, black; costa black (Fig. 11D). Mid femur entirely black. Facial ridges bowed outward (Fig. 2B). Propodeal spiracle crescent-shaped, [2.7]–3.2 times higher than wide.

Length.—[8.8]–9.6 mm.

Head.—Antenna with [48]–53 flagellomeres. Scape longer ventrally than dorsally. Scape without any shelf-like process apically, or with shelf-like process apically, lacking pre-apical shelf. Scape 1.6–[1.7] times longer than maximally wide. First flagellomere [1.2]–1.4 times longer than second flagellomere, [1.3]–1.4 times longer than third flagellomere. Third flagello-

mere 1.0–[1.1] times longer than wide. Apical flagellomere 1.8–[1.9] times longer than wide. Flagellomere length [equal to or greater than width], or distinctly less than width. Horizontal length of eye 1.4–[1.7] times longer than length of head behind eye. Transverse diameter of posterior ocellus 1.0–[1.1] times post-ocellar length. Distance between posterior ocellus and eye 3.5 times post-ocellar length. Longitudinal bump between antennal sockets present. Facial ridges bowed outward. Deep anterior groove between antennal sockets very weak. Area between ridges not filled in, level with rest of face. Median carina on face present, developed into raised tear-drop shaped area. Area between median carina and ridges with ladder-like series of horizontal carinae. Ridges running at 45° angle from middle ridge to antennal sockets strong. Groove around eyes present and crenulate. Eye height 1.3 times greater than eye width, 1.2 times greater than width of face. Width of head 2.2 times greater than width of face. Intertentorial distance 2.0–[2.3] times clypeus height. Tentorio-ocular distance 1.0–[1.1] times longer than clypeus high. Clypeus partially filled in dorsally. Ventral margin of clypeus concave. Area around clypeus with series of large crenulae and sharp ridge separating from rest of face. Face 1.1–[1.2] times wider than high. Malar suture paralleled by 2 ridges. Malar space 0.2 times eye height.

Mesosoma.—Mesosoma [1.4]–1.5 times longer than high. Pronotum with deep, smooth groove anteriorly. Notaulus not impressed. Border between mesoscutum and scutellum lacking groove, or [with carinate groove]. Border between mesoscutum and scutellum lacking median carina and not enlarged into a median pit. Propodeal spiracle crescent-shaped, [2.7]–3.2 times higher than wide.

Fore tibia [1.1]–1.2 times longer than fore femur. Fore tarsus not laterally compressed, [1.6]–1.7 times longer than fore femur. Fore basitarsus [3.3]–4.3 times lon-

ger than wide, [1.6]–1.7 times longer than second tarsomere. Hind femur 3.7–[4.1] times longer than wide, 1.9–[2.1] times longer than basitarsus. Hind tibia [2.5]–2.6 times longer than basitarsus. Outer and inner hind tibial spurs 0.5 and [0.6]–0.7 times longer than basitarsus, respectively. Hind basitarsus [4.2]–4.5 times longer than wide.

Fore wing venation: 1M and 1cu-a intersect. (RS+M)b broken apically. 1M 1.5–[1.7] times longer than 1RS. 2M 3.3–[3.8] times longer than r-m. 1m-cu 1.0 times longer than r, 1.5–[2.0] times as thick as (RS+M)a. 2RS 1.0–[1.2] times longer than r-m. 3RSa 2.8–[3.1] times longer than r-m, [4.0]–4.4 times longer than r. 3RSb 4.6–[5.0] times longer than r. C+SC+R and 1RS forming an angle of 73°. Fore wing length [9.0]–10.3 mm.

Hind wing vein R1a 1.4 times longer than 1r-m.

Metasoma.—Base of petiole deeply excavated. First tergite with strongly raised rectangular bump. First tergite with lateral carina closely paralleling median bump but not forming notches, lacking pair of lateral carina entirely separated from median bump. First tergite 0.9–[1.0] times longer than wide. Border between first and second tergite [straight with edges curving anteriorly], or completely rounded. Second tergite with strongly pinched-up area not reaching third tergite. Suturiform articulation with weak, smooth, V-shaped, weakly arched groove; with carina along anterior margin. Second tergite 0.4–[0.5] times longer than wide, 0.7–[0.9] times longer than third tergite. Third tergite [0.5]–0.6 times longer than wide. Hypopygium with flat to [convex] dorsal border. Ovipositor 0.9 times body length.

Color.—Head black except maxillary and labial palpomeres black basally, yellowish orange apically, or entirely yellowish orange.

Mesopleuron mostly black. Metanotum yellowish orange. Propodeum yellowish orange, or black laterally, yellowish or-

ange dorsally. Metapleuron black, or mostly black with some yellowish orange by hind wing. Legs entirely black except as follows: fore tibia black but yellowish orange in basal twelfth, or black but yellowish orange in basal and apical sixths. Fore tarsus yellowish orange but telotarsus black. Mid trochantellus yellowish orange. Mid tibia mostly black, but basal fifth yellowish orange. Mid tarsus mostly yellowish orange but telotarsus black. Hind trochantellus yellowish orange. Hind tibia mostly black but yellowish orange basally. Hind tarsus mostly black but basal part of basitarsus and 4th tarsomere orange, or black but basal part of basitarsus orange. Fore wing banded: yellow, black, yellow, black, costa black. Hind wing banded: yellow, black, yellow, black apical black band complete, or banded: yellow, black, yellow.

Terga 1–4 yellowish orange. Tergum 5 black or yellowish orange. Terga 6–8 and ovipositor sheath black.

Distribution and material examined.—Known only from Suriname. 2♀ examined.

Holotype ♀. SURINAME: Boven Corantyn, Coer-oeni eil., 7.x.1959, Creutzberg, (RMNH—JL000228). **Paratype**. SURINAME: 1♀, Tapanahoni Saniki, 9.v.1954, D.C. Geijskes (RMNH—JL000229).

Etymology.—For Michael Robertson.

***Cyclaulacidea sharkeyi* Leathers n. sp.**

Figs. 3B, 12A

Diagnosis.—Ovipositor sheath black with some yellowish orange in apical third (but black at apical tip) (Fig. 12A). Suturiform articulation with shallow groove (as in Fig. 7B). Strongly raised bump on petiole rectangular (as in Fig. 8B).

Length.—8.8–[14.1] mm.

Head.—Antenna with 54–58 [57] flagellomeres. Scape longer ventrally than dorsally. Scape with shelf-like process apically, lacking pre-apical shelf, 1.9–2.3 [2.2] times longer than maximally wide. First flagellomere 1.2–1.5 [1.4] times longer

than second flagellomere, 1.4–[1.6] times longer than third flagellomere. Third flagellomere [1.1]–1.3 times longer than wide. Apical flagellomere 1.8–2.3 [2.1] times longer than wide. Flagellomere length [equal to or greater than width], or distinctly less than width. Horizontal length of eye [0.7]–0.8 times longer than length of head behind eye. Transverse diameter of posterior ocellus 0.9–1.4 [1.1] times post-ocellar length. Distance between posterior ocellus and eye 3.8–5.6 [4.8] times post-ocellar length. Longitudinal bump between antennal sockets present. Facial ridges [parallel] or diverging outward straight from clypeus to antennal sockets. Deep anterior groove between antennal sockets very weak. Area between ridges filled-in creating a raised median area. Median carina on face present; developed into raised chevron or butterfly-shaped area. Area between median carina and ridges smooth. Ridges running at 45° angle from middle ridge to antennal sockets absent, or weak, or [strong]. Groove around eyes present and smooth. Eye height 1.3–1.5 [1.4] times greater than eye width; 1.0–1.2 [1.1] times greater than width of face. Width of head 1.9–2.3 [2.1] times greater than width of face. Inter-tentorial distance [1.7]–2.3 times clypeus height. Tentorio-ocular distance 1.0–1.3 [1.2] times longer than clypeus high. Clypeus completely filled in but uneven. Ventral margin of clypeus [flat], or concave. Area around clypeus with series of large crenulae and sharp ridge separating from rest of face. Face [1.1]–1.2 times wider than high. Malar suture paralleled by [2]–5 ridges. Malar space [0.2]–0.3 times eye height.

Mesosoma.—Mesosoma 1.4–1.7 [1.5] times longer than high. Pronotum with deep, smooth groove anteriorly. Notaulus not impressed, or [weakly impressed]. Border between mesoscutum and scutellum with carinate groove. Border between mesoscutum and scutellum lacking median carina; median area not enlarged, or

enlarged into a median pit. Propodeal spiracle oval, 1.8–[2.4] times higher than wide.

Fore tibia 1.0–[1.2] times longer than fore femur. Fore tarsus not laterally compressed, 1.5–1.7 [1.6] times longer than fore femur. Fore basitarsus 3.9–5.7 [4.3] times longer than wide, [1.7]–1.9 times longer than second tarsomere. Hind femur 3.8–[4.2] times longer than wide, 1.6–[1.8] times longer than basitarsus. Hind tibia [2.5]–2.6 times longer than basitarsus. Outer and inner hind tibial spurs 0.4 and 0.5–[0.6] times longer than hind basitarsus. Hind basitarsus 5.2–6.2 [6.1] times longer than wide.

Fore wing venation: [1M and 1cu-a intersect], or 1cu-a intersects Cu distad 1M. (RS+M)b completely tubular, or broken apically. 1M 1.8–2.1 [1.9] times longer than 1RS. 2M [3.1]–3.6 times longer than r-m. 1m-cu [1.2]–1.6 times longer than r, 1.1–1.7 [1.6] times as thick as (RS+M)a. 2RS [1.0]–1.2 times longer than r-m. 3RSa [2.9]–3.2 times longer than r-m, [5.0]–6.3 times longer than r. 3RSb [4.6]–6.0 times longer than r. C+SC+R and 1RS forming an angle of 67–73° [72°]. Fore wing length 8.7–[12.8] mm.

Hind wing vein R1a [1.3]–1.5 times longer than 1r-m.

Metasoma.—Base of petiole not deeply excavated. First tergite with strongly raised rectangular bump. First tergite with lateral carina closely paralleling median bump but not forming notches, lacking pair of lateral carina entirely separated from median bump. First tergite 1.1–[1.3] times longer than wide. Border between first and second tergite straight with edges curving anteriorly. Second median tergite smooth, with slightly elevated pinched-up area anteriorly. Suturiform articulation with weak, smooth, M-shaped, weakly arched groove; with carina along anterior margin. Second tergite [0.5]–0.6 times longer than wide, 0.7–0.9 [0.8] times longer than third tergite. Third tergite [0.5]–0.7 times longer than wide. Hypopygium

with convex dorsal border. Ovipositor 0.8–1.1 [1.0] times body length.

Color.—Yellowish orange and black. Head black except maxillary and labial palpomeres yellowish orange.

Mesosoma yellowish orange except propleuron black. Fore and mid legs yellowish orange except mid tibia sometimes black in apical quarter and telotarsus of mid tarsus black. Hind coxa black. Hind trochanter black, or yellowish orange. Hind trochantellus yellowish orange. Hind femur yellowish orange in basal half, black in apical half, or mostly black but yellowish orange in basal twelfth. Hind tibia mostly black but yellowish orange basally. Hind tarsus black. Fore wing banded: yellow, black, yellow, black, costa yellow. Hind wing yellow in basal half, black apically.

Terga 1–4 yellowish orange. Tergum 5 yellowish orange, or yellowish orange anteriorly, black posteriorly, or black dorsally, yellowish orange laterally. Tergum 6 black, or black dorsally, yellowish orange laterally, or mostly yellowish orange with some black spots anteriorly. Tergum 7 black, or black dorsally, yellowish orange laterally. Tergum 8 black. Ovipositor sheath black with some yellowish orange in apical third (but black at tip).

Distribution and material examined.—Known only from type locality of Dirkschoop, Suriname. 4♀♀, 1♂ examined.

Holotype ♀. SURINAME: Dirkschoop, 21.v.1963, J.v.d. Vecht, (RMNH—JL000203). *Paratypes*. SURINAME: Dirkschoop, 21.v.1963, J.v.d. Vecht: 3♀♀ (RMNH—JL000236, 000238, 000239), 1♂ (RMNH—JL000237).

Remarks.—All specimens of this species appear to have been collected with a fly-swatter or similar instrument. Some morphological characters, especially continuous ones, may be distorted in this description.

Etymology.—For Michael J. Sharkey of The University of Kentucky.

*Cyclaulacidea snyderorum***Leathers n. sp.**

Figs. 3A, 5F, 8B, 10C

Diagnosis.—Maxillary and labial palpomeres entirely black (Fig. 10C). Antenna with 46–52 flagellomeres. Facial ridges diverging outward straight from clypeus to antennal sockets (Fig. 3A). Scape longer ventrally than dorsally (Fig. 5F), 1.8–1.9 times longer than maximally wide.

Length.—7.2–[9.2] mm.

Head.—Antenna with 46–[52] flagellomeres. Scape longer ventrally than dorsally. Scape with shelf-like process apically, lacking pre-apical shelf, [1.8]–1.9 times longer than maximally wide. First flagellomere 1.3–[1.4] times longer than second flagellomere and 1.4 times longer than third flagellomere. Third flagellomere [1.1]–1.3 times longer than wide. Apical flagellomere 1.8–[1.9] times longer than wide. Flagellomere length equal to or greater than width. Horizontal length of eye 1.7 times length of head behind eye. Transverse diameter of posterior ocellus 0.9–[1.1] times post-ocellar length. Distance between posterior ocellus and eye 2.9–[3.3] times post-ocellar length. Longitudinal bump between antennal sockets present. Facial ridges diverging outward straight from clypeus to antennal sockets. Deep anterior groove between antennal sockets absent. Area between ridges filled in creating a raised median area. Median carina on face present, developed into raised chevron to butterfly-shaped area. Area between median carina and ridges [with ladder-like series of horizontal carinae], or irregular rugose, lacking any strong carinae. Ridges running at 45° angle from middle ridge to antennal sockets strong. Groove around eyes present, smooth or [crenulate]. Eye height 1.3 times greater than eye width, 1.3 times greater than width of face. Width of head 2.3–[2.4] times width of face. Inter-tentorial distance 2.5–[2.8] times clypeus height. Tentorio-ocular distance 1.1–[1.2] times longer

than clypeus high. Clypeus [partially filled in dorsally], or completely filled in but uneven. Ventral margin of clypeus concave. Area around clypeus with series of large crenulae and sharp ridge separating from rest of face. Face 1.0–[1.1] times wider than high. Malar suture paralleled by 2–[5] ridges. Malar space 0.2 times eye height.

Mesosoma.—Mesosoma 1.5–[1.6] times longer than high. Pronotum with deep, smooth groove anteriorly. Notaulus not impressed. Propodeal spiracle oval to [crescent-shaped], 1.9–[2.3] times higher than wide.

Fore tibia 1.1–[1.2] times longer than fore femur. Fore tarsus not laterally compressed, 1.6–[1.7] times longer than fore femur. Fore basitarsus [4.5]–5.1 times longer than wide, [1.5]–1.8 times longer than second tarsomere. Hind femur [4.0]–4.4 times longer than wide, 1.7–[1.8] times longer than basitarsus. Hind tibia 2.4–[2.6] times longer than basitarsus. Outer and inner hind tibial spurs 0.4–[0.5] and 0.6 times longer than basitarsus, respectively. Hind basitarsus [4.4]–5.2 times longer than wide.

Fore wing venation: 1M and 1cu-a intersect. (RS+M)b broken apically. 1M 1.7–2.1 [1.8] times longer than 1RS. 2M 3.2–3.5 [3.4] times longer than r-m. 1m-cu [0.9]–1.3 times longer than r, [1.5]–1.6 times as thick as (RS+M)a. 2RS 1.1–[1.2] times longer than r-m. 3RSa [2.8]–2.9 times longer than r-m, [3.8]–5.4 times longer than r. 3RSb [4.1]–5.4 times longer than r. C+SC+R and 1RS forming an angle of [70]–76°. Fore wing length 7.0–[9.1] mm.

Hind wing vein R1a [1.2]–1.4 times longer than 1r-m.

Metasoma.—Base of petiole deeply excavated. First tergite with strongly raised rectangular bump. First tergite with lateral carina closely paralleling median bump but not forming notches, lacking pair of lateral carinae entirely separated from median bump. First tergite [0.8]–0.9 times longer than wide. Border between first

and second tergite straight with edges curving anteriorly. Second tergite with strongly pinched-up area not reaching third tergite. Suturiform articulation with weak, smooth, V-shaped, weakly arched groove; with carina present along anterior margin. Second tergite [0.4]–0.5 times longer than wide, [0.7]–0.8 times longer than third tergite. Third tergite [0.5]–0.6 times longer than wide. Hypopygium with flat to [convex] dorsal margin. Ovipositor 1.1 times body length.

Color.—Entirely black except lateral parts of terga 1–3 reddish orange and sometimes basal parts of fore tarsus and entire or apical parts of hind trochantellus yellowish orange or red. Wings entirely black.

Distribution and material examined.—Known only from type locality at La Selva, Costa Rica. 3 ♀ examined.

Holotype ♀. COSTA RICA: Heredia: F. La Selva, 3km S. Pto. Viejo, 4.iv.1987, H.A. Hespeneheide (ESUW—JL000230). **Paratypes**. COSTA RICA: Heredia: 1 ♀, F. La Selva, 3km S. Pto. Viejo, 1.iv.1980, H.A. Hespeneheide (ESUW—JL000107); 1 ♀, LaSelva Res. Sta., 24–30.viii.1988, W.J. Hanson (EMUS—JL000101).

Remarks.—Coloration appears almost identical to *C. adairae*, but can be consistently distinguished using the diagnostic characters in the key.

Etymology.—For William E. and Amanda M. Snyder of Washington State University.

ACKNOWLEDGEMENTS

We thank Jill Townzen for help with ArcGIS, Gavin Broad and Donald Quicke for comments on the manuscript, and the following people who helped to provide specimens for this study: Bob Zuparko at CAS and the University of California Berkeley, Colin Brammer at EMUS, Scott Shaw at ESUW, Yaneth Muñoz-Saba at IAVH, David at MNHN, Alexandre Aguiar at MZSP, Kees van Achterberg at RMNH, Bob Wharton at TAMU, David Smith at USNM, Philip Clausen at the University of Minnesota, Joe Fortier at Saint Louis University, Henri Goulet at the Canadian National Collection, Philip Perkins at the Museum of Comparative Zoology (Harvard University), Martha Potts at the University of Kentucky, Robert Sites at the Wilbur R. Enns Entomology Museum (University of Missouri), David Wahl at the American Entomo-

logical Institute, and Jim Wiley at the Florida State Collection of Arthropods. This work was supported by the Harold and Leona Rice Endowment for Systematic Entomology, NSF Grant DEB-0093392 to D.D. Judd, the George Ferguson Endowment Fund, and the USDA Western Forest Insect Collection. NSF Grant DEB-0205982 to Mike Sharkey supported the collecting of new specimens in Colombia.

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APPENDIX 1

The following new specimens of *C. bruchivorus* were examined in this study: BRAZIL: 4 ♀, Rondonia, Faz. Rancho Grande, 62km S. Ariquemes, 12–22.xi.1991, E.M. Fisher (TAMU—JL000047, 000048, 000247, 000248). BOLIVIA: 1 ♀, Rurrenabaque, Depto. Beni, 175m, x.1956, L.E. Pena (OSUO—JL000108); 1 ♀, Rurrenabaque, Rio Beni, Mulford Bio. Expl., x.1921–1922, W.M. Mann (USNM—JL000245); 1 ♀, Huachi-Beni, Mulford Bio. Expl., ix.1921–1922, Wm.M. Mann (TAMU—JL000246). SURINAME: 1 ♀, Tibiti savanne, Suriname Exp. 1948–1949, 17.i.1949, D.C. Geijakes (RMNH—JL000249); 1 ♀, Republiek, 10.v.1963, J.v.d.Vecht (RMNH—JL000250); 1 ♀, Tapanahonie, Drietabbetje, 5.v.1952, D.C. Geijakes (RMNH—JL000251); 1 ♀, Cowahka, 12.iv.1962, D.C. Geijakes (RMNH—JL000252).

The only new specimen of *C. matilei* examined in this study: COLOMBIA: 1 ♀, Amazonas, PNN Amacayacu, Mocagua, 150m, 12–19.iii.2000, A. Parente (IAVH—JL000201).

Notes on Host Searching by the Parasitic Wasp *Zaglyptogastra* Ashmead (Hymenoptera: Braconidae: Braconinae) in Kibale Forest, Uganda

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Abstract.—Females of more than one species of the braconine wasp genus *Zaglyptogastra* were observed, on multiple occasions, probing with their highly mobile ovipositors into dead wood through the exit holes made by various beetles (Scolytidae and others) which were themselves far too small to be hosts of the wasp. Given that the structure of the ovipositor in this genus precludes drilling, it is proposed that the intersections of burrows of smaller beetles with those of the actual host provides one possible route by which hosts can be located. Our failure to find any parasitized hosts in the substrate the wasps were probing suggests that their mode of host location is not very reliable.

Host records are not available for about half of the parasitic wasp genera known from the Afrotropical Region, and for far fewer if we consider only those genera that are endemic to the continent. Even when records are present in the literature, there are potential problems. Misidentifications of either host or parasitoid or both are not infrequent, and for parasitoids of concealed hosts in particular there is the problem of mis-association (Noyes 1994, Shaw 1994, 2003). The next issue is that even if a good host record exists for a genus, the likelihood is that for most genera there is only one host record, so generalising is a risky business. Here we report on species of the braconid genus *Zaglyptogastra* Ashmead which suggests that the host associations of the genus may be more complicated than previously thought.

Zaglyptogastra is a genus of large wasps (up to 2cm body length) that are restricted to the Palaearctic. It is also one of several genera and species of Braconinae that

have remarkably modified ovipositors that appear to be adaptations to either penetrating under the edge of a host retreat or steering the wasp's ovipositor tip within the host's retreat (Quicke 1991b, Quicke et al. 1995). *Zaglyptogastra* has the apical third or so of the ovipositor formed into a series of (typically three) arch-like regions in common with, though more developed than in *Undabracoon* Quicke, *Serrundabracoon* van Achterberg and several tersilochine and cremastine ichneumonids. The mechanics of the ovipositor of at least some *Zaglyptogastra* species were worked out by Quicke (1991b) who showed that, by pushing the lower ovipositor valves posteriorly relative to the upper valves, the whole tip of the ovipositor can be bent ventrally through more than 180°. This gives *Zaglyptogastra* females the ability not only to access hosts more easily but also to sting—though the effect isn't very painful (pers. obs.). However, a consequence of this ovipositor modification, in which the apex of the up-

per valve is typically blunt and broadly rounded, is that the female wasps cannot 'drill' through solid substrate to reach their hosts, or even thread their ovipositors through the narrow cracks and fissures that many parasitic wasps probably do (Gauld 1991). There are no absolutely definite host records for *Zaglyptogastra* species, though there is compelling evidence that one species is a parasitoid of larvae of the cerambycid beetle, *Dirphya princeps* Jordan, (Crowe 1962 [as *Iphiaulax* sp.], El-Heneidy and Quicke 1991), a minor pest of coffee in East Africa. *Dirphya princeps* bores coffee twigs and makes frass holes at intervals along the twigs, and it was supposed that it was through these frass holes that the *Zaglyptogastra* gained access to its presumed host.

OBSERVATIONS

Observations were made in both August 2003 and August 2004 near Makerere University Biological Field Station, Kanyawara, Kibale National Park, West Uganda, in an area of montane rain forest that was lightly logged in 1960 (Area 14 in Struhsaker 1997). Multiple females of what appeared to be a single *Zaglyptogastra* species were observed ovipositor probing into each of two dead trees in Kibale in 2003, and multiple females of at least two species were observed (and filmed) ovipositor probing on a dead, up-rooted tree in Kibale in 2004.

At the first of the 2003 observation sites, in the forest near a tree fall gap, up to 4 females were seen sitting on, or probing into, an approximately 2m high dead small tree trunk approximately 10cm in diameter (site A). Most were concentrating their attention on a small region of trunk approximately 1.3 m above the ground, though one or two individuals were occasionally observed investigating near the base of the dead tree.

At a second 2003 site (site B), up to three females were observed probing a small, dead, felled tree by the side of a forestry

road. On both occasions, the wasps were seen probing their ovipositors into small round beetle emergence holes (Fig. 1), which at the second site, appeared to belong to scolytids that had developed within the wood (presence of scolytids was verified by dissection and discovery of characteristic sub-cortical galleries). At the second site we started to saw the branch that the wasps had been probing with their ovipositors for future dissection, and during one pause, a female *Zaglyptogastra* alighted on the log and started probing her ovipositor into the saw cut.

In 2004, up to 4 females, clearly representing two species (based on size and coloration; see Quicke 1991a) were observed, over a period of several days, searching and ovipositor probing into small beetle emergence holes in a horizontal trunk (c. 15cm diameter) approximately 2 m off the ground of a *Trilepisium madagascariense* D.C. (= *Bosqueia phoberos* Baill.) (Moraceae) tree which had been up-rooted due to the fall of an adjacent *Celtis africana* Burm. f. (Celtidaceae) tree strangled by *Ficus brachylepis* Welw. Ex Hiern (Moraceae). The *Trilepisium* had many black, charcoal-like, more or less round and slightly raised fungal patches the centres of many of which had one or more small circular, beetle emergence holes, and it was primarily in these that the *Zaglyptogastra* females probed their ovipositors.

All these wood substrates were removed for dissection at a more convenient locality. The first (i.e. the small, standing, dead tree) and the *Trilepisium* yielded not a single suitable potential host at the site of interest at about 1m above the ground, though one large beetle larva was found near the base. For the road-side tree, dissection revealed several suitably sized but active (i.e. unparalysed and therefore presumably unparasitised) beetle larvae immediately below the bark and a few apparently conspecific ones that had bored deeper into the substrate presumably to make pupation chambers.



Fig 1. *Zaglyptogastra* 'hot spot' showing many scolytid beetle emergence holes and field saw for scale.

At the road-side tree and on the *Trilepisium*, it was possible to observe how *Zaglyptogastra* females used their antennae during host searching. While antennae of set and of living females normally show no special features (Fig. 2A; arrow), those of host-locating females are sharply angled ventrally close to their tips, especially in lateral view (Fig. 2B-E), and it seems likely that this is an adaptation to penetrating the openings of potential intermediary burrows such as those of scolytids. Subsequent dissection of the length of the road-side log where the wasps were ovipositor-probing revealed several cerambycid larvae, mostly in the cambial layer and apparently too small for parasitism by the *Zaglyptogastra* females. A few larger cerambycid larvae deeper in the wood were also found but none of them had been parasitized or paralyzed.

DISCUSSION

Although the new observations presented here do not provide any definite host records for the genus, they do indicate a number of potentially important points. Firstly, there is the possibility that *Zaglyptogastra* species attacking beetle hosts in larger pieces of dead wood may sometimes necessarily utilise the borings and exit holes made by other insects (such as scolytids) to gain access to the deeper burrows of suitable hosts because they cannot 'drill' through a solid wood substrate themselves. Secondly, that several females were observed, over a period of days, investigating pieces of substrate that upon dissection were found to be devoid of suitable hosts points to the use of unreliable host-searching cues, and it is tempting to speculate that these may in part involve



Fig. 2. Living *Zaglyptogastra* females. A, individual from forest site stinging senior author (white arrow indicates the strongly bent ovipositor apex with sharper lower valves penetrating skin; black arrow indicates the unbent antennae when not host searching); B-E female from road-side site: B, inserting ovipositor into beetle emergence hole, note apically strongly bent antennal tips (arrows); C, detail from B; D, E, host-searching females, lateral and front views.

volatiles from the borings of the smaller non-host beetle intermediaries. Scolytids and several other groups of 'ambrosia' beetles have obligate relationships with symbiotic fungi (Graham 1967). Thus, scolytid and similar infected wood is likely to give off a reliable odour cue for location of the fungal/scolytid system, and it is possible that other parasitoids that emerge in close association with such a substrate might learn this potentially useful cue and employ it during their initial host-searching activities. Since the *Zaglyptogastra* wasps reported upon here have no other real option for host location than to use holes made by small, non-host, beetles, then the use of, for example, scolytid-

associated signals, might often lead to them investing a lot of time searching substrates in which there are no suitable large hosts.

The bending of the tips of the antenna by host-searching female *Zaglyptogastra* was completely unexpected as none of many hundreds of set individuals in museum collections examined by the senior author show any sign of this posture, and subsequent examination of antennae in preserved individuals suggests no special morphological features. Given the lack of internal flagellar musculature in pterygote insects (Chapman 1982, R. Romani pers comm.), the mechanism involved awaits discovery.

ACKNOWLEDGEMENTS

We would like to extend sincere thanks to the Tropical Biology Association, and in particular to Rosie Trevelyan, for their support during our visit to Kibale, Dr John Kasenene of Makerere University Biological Field Station for tree identification, the staff of MUBFS for all their help and hospitality, Dr Roberto Romani (University of Perugia) for information on insect antennal structure, and Dr Mark Shaw for many useful comments on an earlier draft of the MS.

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Trigastrotheca laikapiensis sp. nov. (Hymenoptera: Braconidae):
A New Species of Brood Parasitic Wasp that Attacks Foundress
Queens of Three Coexisting Acacia-ant Species in Kenya

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Abstract.—*Trigastrotheca laikapiensis* Quicke sp. nov., from Kenya, is described and illustrated. It is shown to be an ant brood parasite in claustral colonies of three acacia ant species which inhabit *Acacia drepanolobium* thorns. The larvae of *T. laikapiensis* sp. nov. consume ant eggs, larvae and pupae. Brood parasitism was found in up to 20% of *Crematogaster mimosae* and *C. nigriceps*-occupied thorns, but was far rarer in the case of *Tetraponera penzigi*. *Crematogaster* foundress queens actively defend *T. laikapiensis* sp. nov. larvae, cocoons and recently eclosed adults.

Two new combinations and one new name are proposed: *T. inermis* (Guérin-Méneville) **comb. nov.** (on authority of C. van Achterberg) [*Spinaria inermis* Guérin-Méneville, 1848], *T. romani* **nom. nov.** [= *Coelodontus costator* Roman; = *Ichneumon costator* Thunberg, 1822, a junior homonym of *Ichneumon costator* Donovan, 1810] and *T. rugosa* (Szépligeti) **comb. nov.** [= *Bracon rugosa* Szépligeti; = *K. rugosa*: Quicke & Koch, 1990].

Key words.—*Trigastrotheca*, *Kenema*, brood parasitism, *Crematogaster*, *Cordia*, ant colony founding, new combination, new name

Many upland savannas on black cotton soils in East Africa are dominated by a single species of swollen thorn ant-acacia, *Acacia drepanolobium* (Harms) Sjöstedt (Young et al. 1998, Taiti 1992). Within the canopy layer of this relatively simple plant community, up to four species of specialized, symbiotic acacia-ants coexist at fine spatial scales, despite the fact that *A. drepanolobium* host trees are a limited resource for which symbiotic ant colonies compete intensively (Hocking 1970, Palmer et al. 2000, 2003, Palmer 2003, Young et al. 1997). Three of these acacia-ant species (*Crematogaster mimosae* (Santschi), *C. nigriceps* (Emery), and *Tetraponera penzigi* (Mayr)) produce young queens which at-

to initiate new, independent claustral colonies (i.e. ones made by a newly mated queen who seals herself in a thorn to raise her first brood) within swollen thorns on *A. drepanolobium* trees that do not have any other active, mature ant colony. These colonization targets are usually small saplings (< 0.6 m tall), but may occasionally be larger trees recovering from disturbances such as fire or prolonged drought (Stanton et al. 2002). Competition among foundress queens for colonizable swollen thorns is intense, with almost 80% of foundress mortality in claustral colonies attributable to combat with other queens trying to colonize the same swollen thorn (Stanton et al. 2002, Stanton et al. in press). Another major source of failure for claustral foundresses is brood parasitism by a

previously undescribed braconid wasp (*Trigastrotheca laikipiensis* sp. nov. Quicke), which is the focus of this paper, and which could potentially have significant effects on this guild of acacia-ants.

OBSERVATIONS

At our primary study site, the Mpala Research Centre in the Laikipia District of Kenya (0°17' N, 37°52' E; approximately 1800 m elevation), we carefully searched for small saplings of *A. drepanolobium* that were potential colonization targets for foundress queens in June–July of 2001 and 2004. After opening up swollen thorns in which foundresses had sealed themselves and their brood, we examined the brood under a microscope to search for evidence of *T. laikipiensis* sp. nov. parasites. We were unable to identify eggs or very young larvae of the parasitic wasp, but older wasp larvae could be distinguished from ant brood by their more tapered shape. These wasp larvae were often found feeding on ant eggs (Fig. 1a), larvae (Fig. 2), and pupae. The parasitoid cocoons are typically formed free inside the colonies (Fig. 1b). All stages of the parasitoids were apparently accepted by host foundresses, the latter actively guarding wasp larvae, cocoons/pupae and even recently eclosed wasp adults, as though they were legitimate offspring, when challenged by one of us (MLS) (see Fig. 1b).

Ninety percent of claustral colonies founded by a singleton queen lose all of their brood if parasitized by a wasp that reaches late instar stages of development, whereas approximately half of pleometrotic (i.e. colonies founded by more than one queen) groups of *C. mimosae* foundresses produce mature brood even if hosting a successful wasp parasitoid. At two sites within our study area, parasitism by *T. laikipiensis* sp. nov. ranged from 5% to >20% on claustral colonies of *C. nigriceps* (n = 511), and from <5% to 17.5% on *C. mimosae* (n = 475) (Stanton et al. in press). Parasitism by *T. laikipiensis* sp. nov.

on claustral colonies of *Tetraponera penzigi* was rare in all of our samples (n = 231), suggesting either that the wasp specializes on *Crematogaster* in this system, or that *Tetraponera* foundresses tend to be intolerant of its presence. It is likely, however, that these parasitism rates are underestimates because *Trigastrotheca laikipiensis* sp. nov. eggs were never recognized. Some of the braconid brood parasitoids are themselves attacked by a still-unidentified endoparasitoid eurytomid wasp.

In most cases only a single *Trigastrotheca* larva was observed in a nest, but on a few occasions (< 5% of observations) two parasitoids were present. However, because *Trigastrotheca* eggs and early larvae have not been recognized, this estimate of multiple parasitism is almost certainly an underestimate. On two occasions, out of many hundreds, one cocoon and one late instar parasitoid larva were observed in a colony, indicating that two *T. laikipiensis* sp. nov. can probably successfully complete development, at least occasionally.

TAXONOMY

Trigastrotheca Cameron

Trigastrotheca Cameron (type species *Trigastrotheca trilobata* Cameron, 1906)

Coelodontus Roman (type species *Ichneumon costator* Thunberg, 1822) synonymized by Quicke (1987), but see below.

Odontopygia Enderlein (type species *Odontopygia tridentata* Enderlein [1918] 1920)

Kenema van Achterberg [type species *Kenema quickei* van Achterberg (1983) synonymized by Quicke (1987)].

Trigastrotheca is a small genus of moderately small parasitic wasps found predominantly in Africa but also known from Australia (Quicke and Ingram 1993) and the Indo-Australian region. They are currently placed in the Braconini and are characterized by the modified 5th metasomal tergite of the female, which has strong submedial posterior emarginations that define a medial and pair of sublateral points. The genus may be identified using

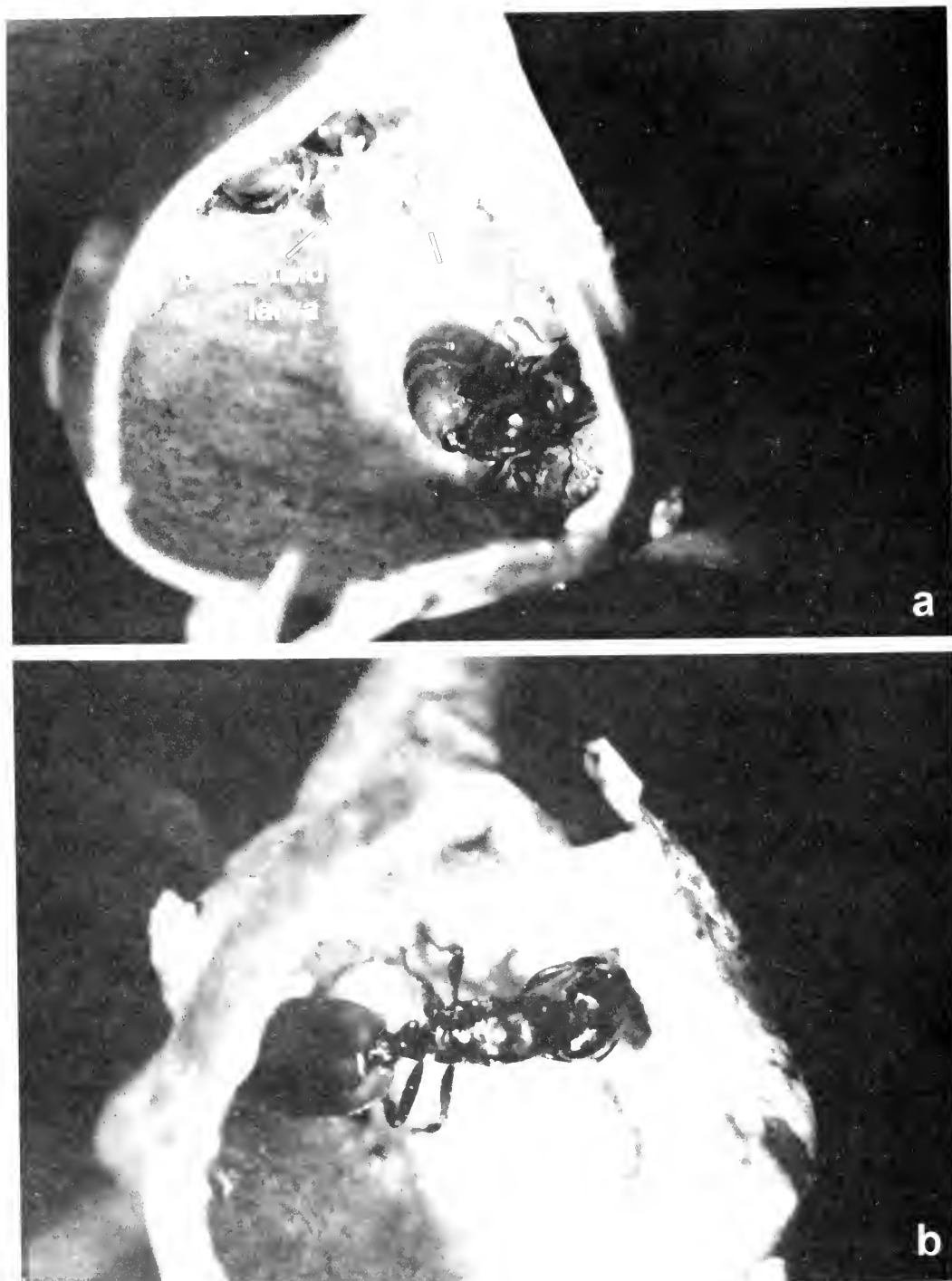


Fig. 1. *Trigaetrotheca laikpiensis* Quicke sp. nov., life stages: a, mid instar larva feeding on *Cremastogaster migneus* eggs with foundress queen in lower right; b, *T. laikpiensis* sp. nov. cocoon in situ protected by *C. migneus* foundress queen.



Fig. 2. Late instar larva of *Trigaetrotheca laikipiensis* Quicke sp. nov., feeding on well-developed *Crematogaster nigriceps* larva.

the key to the Old World genera of Bracninae of Quicke (1987).

The genus *Kenema* was erected based on a single male specimen from Sierra Leone (van Achterberg 1983), and subsequently a 2nd species from Senegal was described by van Achterberg and Sigwalt (1987). According to their diagnostic key, published in the same year that Quicke (1987) synonymized *Kenema* with *Trigaetrotheca*, *Kenema* differs from the latter in that the 5th metasomal tergite completely lacks an apicomedial protuberance and is longer compared to the 4th; it also has less well developed anterolateral grooves on tergites 3–5, and fore wing vein r originates slightly more distally on the pterostigma. Based on our examination of much material in various collections, and additionally members of both sexes of the new species of *Trigaetrotheca* described below, it is clear that the posterior margin of the 5th metasomal tergite is not always tridentate in *Trigaetrotheca*. In males it is simple, though relatively a little longer than in most other genera, and in the case of the new species described here, can have a small sub-posterior medial hump that is presumably a reduced expression of the female's strong medial point. Further, the finely serrate apparent posterior margin of the 4th and 5th metasomal tergites pro-

duced by an overhang of the coriaceous sculptured dorsal surface over the true margin in the new species is closely similar to that in *Kenema serrata* van Achterberg & Sigwalt, suggesting that this might be a synapomorphy for the two species. Because of these observations, the synonymy of *Kenema* with *Trigaetrotheca* originally proposed by Quicke (1987) is hereby supported.

Trigaetrotheca laikipiensis
Quicke, new species
 (Figs 2–4)

Holotype female.—Laikipia District, Kenya. Collected 11 July 2001 at Mpala Research Centre by M. Stanton. Found sealed within a swollen thorn of *Acacia drepanolobium* with a claustral colony of *Crematogaster nigriceps* ants. Bohart Museum of Entomology; University of California; Davis, CA USA.

Paratypes.—2 ♀♀ and 1 ♂: Laikipia District, Kenya. Collected 20 July 2001 at Mpala Research Centre by M. Stanton. Found sealed within swollen thorns of *Acacia drepanolobium* occupied by claustral colonies of *Crematogaster mimosae* ants. BMNH.

Length of body, 4.3 mm, forewing 3.7mm, antenna 2.7mm and part of ovipositor exerted beyond apex of metasoma 1mm.

Head strongly transverse, densely setose; more or less uniformly coriaceous-rugulose. Antenna robust, with 26–27 flagellomeres. Terminal flagellomere robust and distinctly acuminate. Median flagellomeres marginally longer than wide. Height of clypeus: inter-tentorial distance: tentorio-ocular distance = 1.0:3.6:2.2. Face with distinct mid-longitudinal carina on somewhat protruding upper third. Width of head:height of eye:shortest distance between eyes = 2.8:1.0:1.6. Eyes with short sparse setae. Frons with strong mid-longitudinal ridge ending abruptly shortly before anterior ocellus. Posterior ocellar line:transverse diameter of posterior ocellus:shortest distance between posterior ocellus and eye = 4.4:1.0:3.7.

Mesosoma almost entirely coriaceous. Notauli well developed; mesoscutum with a weak but distinct mid-longitudinal ca-

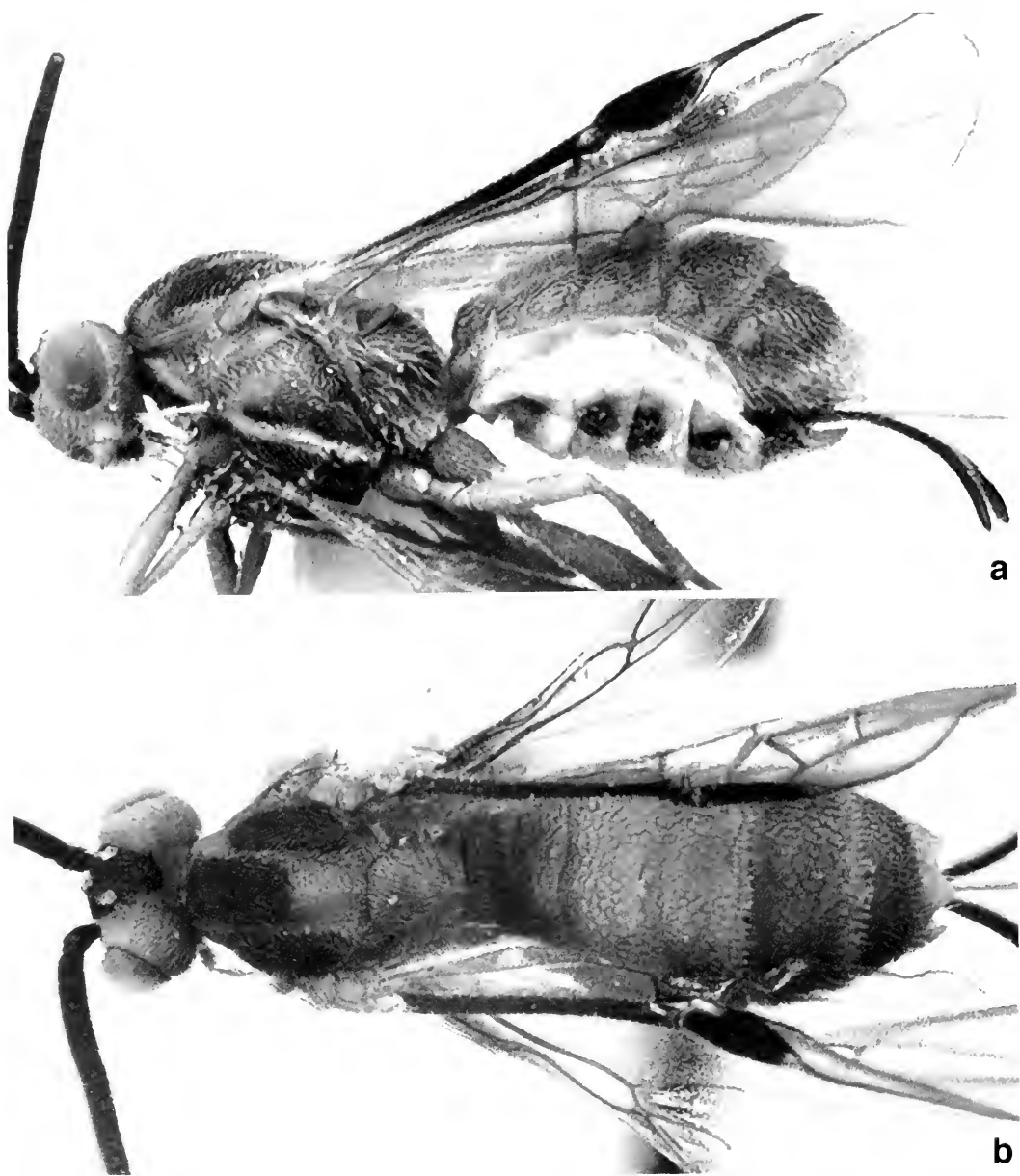


Fig. 3. Automontage® habitus pictures of *Triggastrotecha laikipiensis* Quicke sp. nov., female holotype: a, lateral aspect, b, dorsal aspect.

rina. Pronotum laterally with a deep crenulated curved groove and with strong sub-longitudinal striation below this. Mesopleuron with a weakly depressed broad mesopleural suture, and with an apparently weakly sclerotized almost complete areolus below this. Median area of me-

tanotum with complete mid-longitudinal carina. Propodeum with a complete mid-longitudinal (sub-lamelliform) carina running within a distinct crenulated groove; with distinct straight sub-lateral carinae ending at level of spiracle just above a distinct strongly setose protuberance; with

curved ('C'-shaped) crenulated groove below spiracle; posteriorly with a few distinct anteriorly-diverging short carinae.

Claws with small but distinctly pointed basal lobes. Lengths of fore femur:tibia:tarsus = 1.0:1.0:1.14. Lengths of hind femur:tibia:tarsus = 1.0:1.4:1.3. Hind femur very robust, 3.5 times longer than maximally deep.

Forewing veins 1-M and 1-SR+M meeting at an acute angle near wing margin, vein 1-SR short, forming an angle of 85° with C+SC+R. Lengths of veins r:3-SR:SR1 = 1.0:1.36:5.0. Vein r arising 0.28–0.3 from the base of pterostigma. Pterostigma 3.2 times longer than broad. Lengths of veins 2-SR:3-SR:r-m = 1.45:1.75:1.0. Vein 2-SR+M slightly longer than 1m-cu. Vein 3-CU1 forming a continuous curve with CU1b.

Metasoma strongly coriaceous. Tergites 3–5 with well developed antero-lateral triangular areas. Posterior margins of 3rd and 4th metasomal tergites appearing strongly dentate, but this is due to the strong coriaceous-rugose sculpture combined with a steep posterior margin such that the individual confluences of rugae, each of which bears a posteriorly-directed seta, overhangs the true posterior tergal margins. Posterior margin of 5th tergite of female with deep sub-median semicircular emarginations creating sharp medial point between them; lateral to emarginations border with fine serration. Ovipositor lacking pre-apical dorsal nodus and with no lower valve teeth visible at ×40; in lateral aspect strongly depressed at apex.

Coloration mostly ochreous yellow with variable dark markings (mark on top of head formed into two points anteriorly, large marks on the medial and lateral lobes of the mesoscutum, mesosternum and metasomal sternites), and with whitish, less sclerotized, longitudinal line along the position of the sternaulus (i.e. below the depressed part of the mesopleural suture). Antennae black; mandibles whitish with blackish tips; wing

membrane weakly greyish, wing venation dark brown to blackish. Ovipositor pale brownish.

Variation.—Some paratypes are slightly less extensively marked with black or dark brown, one female paratype having dark spots antero-laterally on the propodeum. The male has the propodeum, scutellum and most of the mesoscutum except a small medio-posterior part, a mark on the middle of the 1st metasomal tergite, and small spots mediolaterally on the 3rd and 4th tergites blackish.

Notes.—Nine species of *Trigastrotheca* have been described previously: *T. inermis* (Guérin-Ménéville) **comb. nov.** (on authority of C. van Achterberg) [*Spinaria inermis* Guérin-Ménéville, 1848], *T. nigricornis* Cameron, *T. quickei* (van Achterberg), *T. romani* **nom. nov.** [= *Coelodontus costator*: Roman; = *Ichneumon costator* Thunberg a junior homonym of *Ichneumon costator* Donovan, 1810; see Yu & Horstman (1997)], *T. rugosa* (Szépligeti) **comb. nov.** [= *Bracon rugosa* Szépligeti; = *K. rugosa*: Quicke & Koch (1990)], *T. serrata* (van Achterberg & Sigwalt), *T. tricolor* Quicke & Ingram, *T. tridentata* (Enderlein) and *T. trilobata* Cameron.

The new species described here can be distinguished from all other described species of *Trigastrotheca* by its smaller size and colour pattern. The apparently closely-related *T. serrata* differs further in having the frons weakly convex, distinctly striate and without a mid-longitudinal carina, the mesoscutum with hardly any trace of notauli and without a mid-longitudinal ridge, the pronotum, propodeum and mesopleuron less heavily sculptured and the latter without mesopleural suture and sternaulus.

DISCUSSION

Parasites are known to have significant impacts on mature ant colonies in some systems (Morrison 1999, Feener 2000), but is not clear how common or ecologically important brood parasites of ant foun-

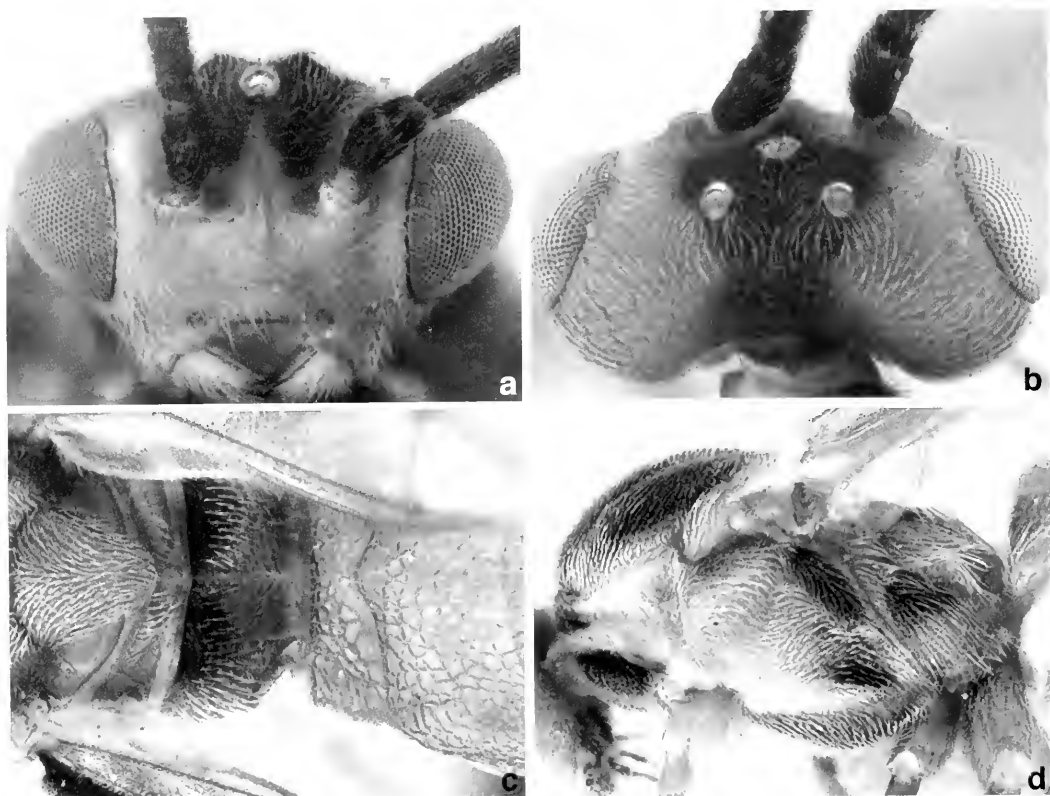


Fig. 4. Automontage® pictures of *Triggastrotthea laikipiensis* Quicke sp. nov., female holotype: a, head, anterior aspect; b, head, dorsal aspect; c, scutellum, propodeum and 1st two metasomal tergites; d, mesosoma, lateral aspect.

dressings might be. We have never observed *T. laikipiensis* within swollen thorns on trees occupied by mature colonies, suggesting that this parasite specializes on the brood of young foundress queens (also see Yu and Quicke 1997).

Many of the important elements of the host-parasite interaction described here remain obscure. The biology of *Triggastrotthea* has previously been unknown. Morphologically (presence of complete mid-longitudinal propodeal carina) the genus appears to be related to several that are associated with galls, such as *Simplicibracon* Quicke, *Testudobracon* Quicke and *Triaspidoagastra* Granger. If this is the case then the group may historically be associated with distinct swellings on plant tissue, although in the other cases, oviposition

appears to be through the plant tissue, and the ovipositor is typically furnished with a distinct dorsal nodus and apico-ventral serrations (Quicke 1987). We do not know how eggs of *T. laikipiensis* enter the sealed chambers of claustral colonies of acacia-ants on *A. drepanolobium*, but it is likely that female wasps locate swollen thorns with foundress queens inside, and then pierce the thorn wall or the queen's entry seal to deposit an egg within the claustral chamber.

Within the Braconidae, parasitism of ants is rare, with only two previously known examples of its evolution. Members of the *Neoneurus* Haliday group of genera in the Euphorinae (previously treated as the subfamily Neoneurinae, but see Belshaw et al. 2001) are endoparasi-

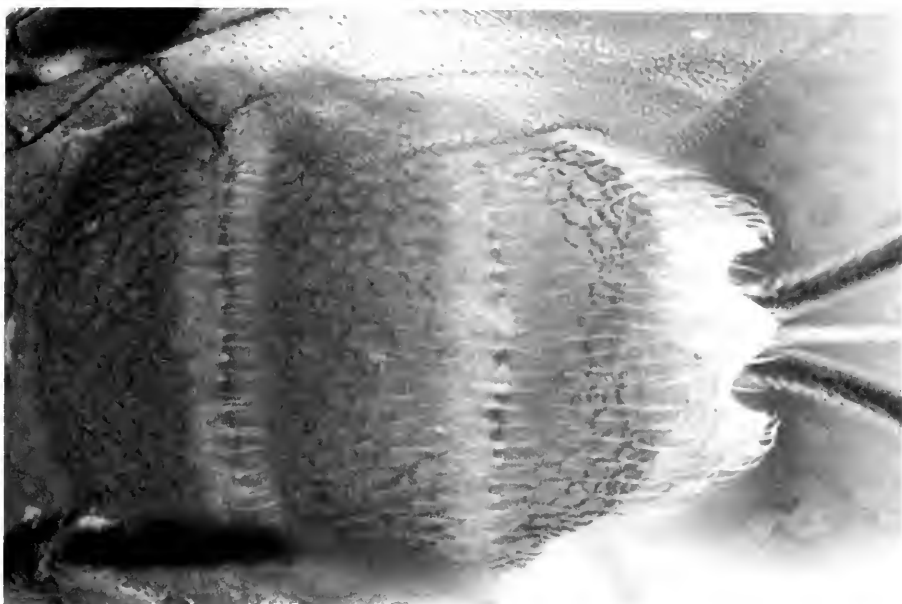


Fig. 5. Automontage® picture of *Trigaetrotheca laikipiensis* Quicke sp. nov., female holotype: detail of posterior of metasoma, showing that dentation at posterior of 4th tergite is due to overhanging and seta-bearing sculpturation.

toids of adult worker ants (Shaw 1993). One species of the New World braconine genus *Compsobraconoides* Quicke parasitizes foundress queens of *Azteca* ants living in domatia in the plant *Cordia nodosa* Lam. (Boraginaceae) (Yu and Quicke 1997), but other members of this group have more typical biologies for the subfamily (Fortier and Nishida 2004, D. Janzen, unpublished data).

Given that the *Trigaetrotheca* wasps probably gain protection from their foundress hosts through chemical crypsis or mimicry, it would be interesting to know whether there is any differentiation between individuals attacking the three ant species at our study sites. However, apart from some slight variation in coloration, all members of the individuals seen are morphologically very uniform, and therefore we currently consider them to represent a single species.

ACKNOWLEDGEMENTS

John Lemboi and Monica Turner provided expert field and lab assistance on this project, and Steve

Heydon and Lynn Kimsey at the Bohart Museum graciously helped with preliminary wasp identification. Kees van Achterberg kindly allowed us to publish on his identification of *Spinaria inermis* and advised on the status of *Coclodontus costator*. Andy Polaszek kindly provided Automontage® facilities. As always, the staff at the Mpala Research Centre provided excellent logistical support. This work was supported by NSF grants DEB-9726663 and DEB-0089706 to M. Stanton, T. Palmer, and T. P. Young.

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***Pappognatha* Mickel (Hymenoptera: Mutillidae: Sphaerophthalminae): New Species, Sex Associations, Hosts, and New Distribution Records**

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Abstract.—Two new species of *Pappognatha* are described: *P. panamensis* Quintero and Cambra, male and female, from Panama, and *P. peruana* Quintero and Cambra, male, from Peru. The previously unknown males of *Pappognatha myrmiciformis* (Cameron, 1897) and *Pappognatha patruelis* (André, 1898) are described, bodies and genitalia are illustrated. *Pappognatha patruelis* is reported as a parasitoid of *Euglossa* sp. (Apidae). New country records are presented for the following four species: *P. speciosa* Mickel, 1939, Colombia and Ecuador, previously known from Peru; *P. egregia* Mickel, 1939, Colombia and Ecuador, previously known from Brazil; *P. obliqua* Mickel, 1939, Peru, previously known from Brazil; *P. myrmiciformis*, Honduras, previously known from Panama and Costa Rica. Honduras represents the northernmost distribution record for this Neotropical genus.

Pappognatha Mickel, 1939, is a Neotropical genus of mutillid wasps, erected to comprise 13 species based on single-sex descriptions: 11 known only from females and 2 from males. Males of *Pappognatha* are rare in collections, a total of five specimens having been reported in the literature: two of *P. obliqua* Mickel, 1939, one of *P. carmo* (Cresson, 1902), and two of *Pappognatha* sp. (Quintero and Cambra 1996). Females are more common, but relatively scarce in reference collections; only 50 female specimens with locality records have been cited in the literature (Mickel 1939, Cambra and Quintero 1992, Yanega 1994, Quintero and Cambra 1996). *Pappognatha* larvae parasitize immature *Euglossa* bees (Roubik 1989). Yanega (1994) reports two findings of *Pappognatha myrmiciformis* as a parasitoid of *Euglossa dodsoni* Moure in Costa Rica and one record of *Pappognatha speciosa* Mickel as a parasitoid of *Euglossa intersecta* Latreille that had nested inside an aerial termite nest in Iquitos, Peru. No additional hosts are known for *Pappognatha* and apparently their parasitism is restricted to bees of the genus *Euglossa*. The development of strong mandibles (Figs. 5–

7) in both sexes of *Pappognatha* is probably an adaptation to tear open and exit the hard resin nests of *Euglossa* by the newly eclosed adults.

Because of the great resemblance between *P. myrmiciformis* and the ant *Camponotus sericeiventris* Guérin-Ménéville some authors (e.g. Wheeler 1983) assumed erroneously that the mutillid was a parasitoid or a brood parasite of that ant (Brothers *et al.* 2000).

Mickel (1939) suggested two possible sex associations, based on distribution and collection data: *P. carmo* (Cresson), probably the male of *P. lauta* (Mickel), from Santarem, Brazil; and *P. obliqua* Mickel, probably the male of *P. pertyi* (Dalla Torre), from Para, Brazil.

Here we describe two new species of *Pappognatha*; one of them being the first to be described from both sexes. We also describe the previously unknown males of *P. patruelis* (André, 1898) and *P. myrmiciformis* (Cameron, 1897), and provide an illustrated key to the six species known from males. We present four new country records and the first host record for *P. patruelis*. We have examined new material of

Pappognatha (46 females and 8 males), bringing the total of currently recorded *Pappognatha* to 94 females and 13 males.

Acronyms for institutions where specimens are deposited are: American Museum of Natural History, New York (AMNH); Museo de Invertebrados G. B. Fairchild, Universidad de Panama (MIUP); Instituto Nacional de Biodiversidad, Costa Rica (INBio). The abbreviations T and S are used for tergum and sternum, respectively.

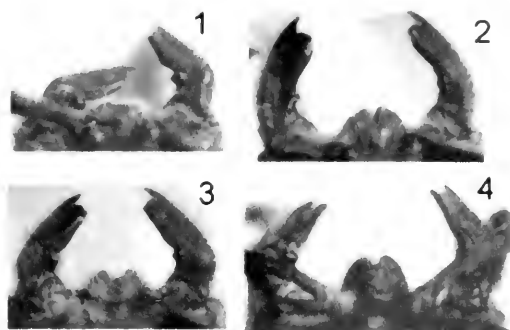
Pappognatha Mickel

Pappognatha Mickel 1939: 330–331. Type species: *Mutilla pertyi* Dalla Torre, 1897, by original designation.

Diagnosis.—*Pappognatha* is the only genus of New World Mutillidae that has males and females with entirely tomentose mandibles, the tomentum consisting of short recumbent pubescence, except for the glabrous tips (Mickel 1939). Both sexes have large quadrate heads, broader than the mesosoma, black integument (except T2 maculations in females) and are about equal in body length (11–14 mm). The males have parameres (Figs. 11, 12) straight, broadest at the base, narrowing towards the apex, triangular in lateral view; volsella (Fig. 13) with cuspis stout, broad and somewhat flattened, with rounded apex; digitus short and stout; penis valve (Fig. 14) without preapical tooth.

KEY TO MALES OF *PAPPOGNATHA* MICKEL

1. Clypeus anterior margin broadly nasutiform, with median U-shaped emargination (Figs. 3, 4) 2
 - Clypeus with broad anterior projection, with either shallow concavity or V-shaped emargination in the middle of anterior margin (Figs. 1, 2) 5
 2. Vertex mostly covered with sparse black setae; clypeus middle emargination about $\frac{1}{4}$ clypeus length 3
 - Vertex mostly covered with sparse pale setae; clypeus middle emargination deeper, nearly $\frac{3}{4}$ clypeus length 4
 3. Clypeus as in Fig. 3; mandible at base with broad, triangular, laminar ventral process (Fig. 5); tibial spurs of mid- and hind legs brown; Central America *myrmiciformis* (Cameron)
 - Clypeus as in Fig. 4; mandible at base with a broad, rounded, laminar ventral process (Fig. 6); tibial spurs of mid- and hind legs pale; Brazil *patruelis* (André)
 4. Mesosternum with distinct, slightly transverse tubercle in front of each middle coxa; anterolateral area of T2 with distinct spot of appressed, pale setae; Brazil *carmo* (Cresson)
 - Mesosternum with distinct, oblique ridge in front of each middle coxa, inner end of ridge almost reaching the margin of coxal cavity; anterolateral areas of T2 with sparse, erect, pale setae; Brazil, Peru *obliqua* Mickel
 5. Clypeus anterior margin with shallow concavity, without V-shaped emargination medially (Fig. 1); mandible at base with broad, triangular, laminar ventral process (as in *myrmiciformis*, Fig. 5); vertex and T3–4 with mostly black setae; dorsoanterior area of propodeum with pale setae, sculpture visible; tibial spurs of mid- and hind legs dark brown to black; Panama *panamensis* n. sp.
 - Clypeus anterior margin convex, with shallow, V-shaped emargination medially (Fig. 2); mandible at base with reduced laminar ventral process (Fig. 7); vertex and T3–4 mostly covered with dense, pale setae; dorsoanterior area of propodeum covered with very dense pale setae, sculpture not visible; tibial spurs of mid- and hind legs pale; Peru *pernana* n. sp.
-



Figs. 1–4. *Pappognatha*, male clypeus, dorsal view. 1, *panamensis*. 2, *peruana*. 3, *myrmiciformis*. 4, *patruelis*.

Pappognatha panamensis Quintero and Cambra, n. sp.
(Figs. 1, 11–14, 16)

Pappognatha sp., female: Cambra and Quintero (1992:473); *Pappognatha* n. sp., female: Yanega (1994).

Male.—Integument black. **Head:** very large, quadrate, slightly broader than long; gena, frons, clypeus and mandible with pale setae; vertex with black setae; clypeus broadly concave on anterior margin (Fig. 1); mandible at base with broad, triangular, laminar ventral process; flagellomere I 1.5× as long as flagellomere II; frons and vertex with medium-sized punctures, most spaces between punctures usually equal to their diameter; ocelli small, distance between inner eye margin and lateral ocellus approximately 6× greatest diameter of the latter. **Mesosoma:** with pale setae, except mesonotum, tegula and anterior half of scutellum with black setae; pronotum, mesonotum and scutellum with dense, closely-spaced punctures; propleuron with scattered, small punctures; dorsal and ventral areas of mesopleuron convex, separated by deep groove, elevated areas with medium-sized punctures, anterior and posterior areas practically impunctate; metapleuron impunctate; propodeum reticulate; scutellum convex; mesosternum with distinct protuberance or tubercle in front of each mid-

coxa. **Legs:** with pale setae, apical tarsomere produced into short lamellate plate covering claw bases; tibial spurs of mid- and hind legs dark brown to black. Wings (as in Fig. 9) infuscated, except basal and subbasal cells with clear area on basal half; stigma poorly developed; marginal cell large, truncate apically; two submarginal cells and traces of a third (as in Fig. 9). **Metasoma:** with pale setae on: dorsal face of T1, lateral margin of T2, very small lateral area of T3 and T4, all sterna except S7; black pubescence on: remainder of T2, other terga, and S7; anterior face of T1 glabrous, impunctate, with conspicuous medial tooth on each lateral margin; T2 with medium-sized punctures laterally, somewhat smaller at the posterior margin, disk glabrous and with punctures scattered; T3 to T6 and S3 to S6 with dense, small punctures interspersed; S2 gibbose anteriorly at the middle, with sparse small punctures. Parameres (Figs. 11, 12) broad at base, narrowing toward apex, triangular in lateral view, with dense large setae on basal two-thirds of ventral margin; volsella (Fig. 13) with cuspis stout, broad and somewhat flattened, with rounded apex, covered with setae that are larger toward apex; digitus short, stout; penis valve as in Figure 14. Length: 10.5 mm.

Female.—Integument black, except T2 with pair of yellow integumental spots. **Head:** frons, vertex and gena with black setae, remainder with thin pale pubescence and scattered, erect, pale setae; frons and vertex densely, distinctly punctate; gena with distinct, separated punctures. **Mesosoma:** dorsum with black setae, except anterior margin of pronotum with pale pubescence, mesonotum with broad, transverse band of pale pubescence interrupted medially by very fine black pubescence, propodeum with lateral pale-pubescent stripe, pleural areas entirely pale pubescent; pronotum and mesonotum with medium-sized, closely-spaced punctures; propleuron with medium-sized, separated punctures; meso- and metapleur-

ron almost smooth; side of propodeum with medium-sized, separated punctures. **Legs:** hind tibia externally with series of three short spines, apical spine at tip of long, conical process; lamellate process of apical tarsomere not emarginate medially; tibial spurs pale. **Metasoma:** T1 with pale pubescence, except anterior face with median triangular area of black pubescence, extending slightly onto dorsal face; T2 with pair of posteromedian, yellow, almost circular integumental spots (Fig. 15), separated by distance almost equal to their diameter; T2 with black setae, except for sparse, pale pubescence on integumental spots, and broad pale pubescence along lateral margin; T3 to T5 with pale pubescence, interrupted medially by narrow black line; sterna with pale setae. Length: 10.6–14 mm ($n = 12$).

Holotype: male.—**PANAMA:** Darien Province: Parque Nacional Darien, Estacion Rancho Frio, Pirre, 80m, 16 Nov 2000–17 Jan 2001, R. Cambra, A. Santos (MIUP), Malaise trap. Paratypes (12 females): Parque Nacional Darien, Pirre Station, 100m, 16 Feb 1989, D. Roubik, 1 ♀ (MIUP); Parque Nacional Darien, Cana—Cerro Pirre trail, 750m, 10 May 2002, D. Curoe, 1 ♀ (MIUP). **Colon Province:** Donoso, Cuatro Callitas, 21–26 Jul 2001, P. Gonzalez, 1 ♀ (MIUP); Piña, Area Protegida San Lorenzo, 5 Sep. 2000, S. Bermudez, 1 ♀ (AMNH). **Panama Province:** 9 km N. El Llano, 29 May 1991, F. Hovore, 1 ♀ (MIUP); 2 km E. Altos de Utive, Pacora, 800m, 11 Feb 1998, R. Cambra, 1 ♀ (MIUP); Capira, Jordanal, 27–30 Jan 2002, P. Gonzalez, 1 ♀ (MIUP). **Comarca Kuna Yala:** Nusagandi, 16 Jan 1991, R. Cambra, 1 ♀ (MIUP). **Cocle Province:** Valle de Anton, 22 Aug 1991, R. Contreras, 1 ♀ (MIUP); El Cope, Division Continental, 900m: 1–2 Sep 1990, D. Quintero, 1 ♀ (MIUP); 1 nov 1992, A. Aiello, 1 ♀ (MIUP). **Chiriqui Province:** Fortuna, Quebrada Arena, 1050m, 8–11 Apr 1999, R. Cambra, A. Santos, 1 ♀ (MIUP).

Diagnosis.—The male of *P. panamensis* differs from the other species of the genus by the shallow concavity on the anterior margin of the clypeus, without a medial emargination. The males of *P. panamensis* and *P. myrmiciformis* are the only known *Pappognathia* with brown to dark brown pubescence on mid- and hind legs. The female of *P. panamensis* is similar to *P. pertyi*

(Dalla Torre) from Brazil but differs in the totally black vertex; the mesonotum with a broad, transverse band of pale pubescence, narrowly interrupted medially by a line of black pubescence; and T3–5 with pale pubescence, narrowly interrupted medially by a line of black pubescence. The female of *P. pertyi* has the vertex with an inconspicuous V-shaped spot of pale pubescence; the mesonotum with a transverse band of pale pubescence widely interrupted medially by black pubescence; and T3–5 with pale pubescence, widely interrupted medially by black pubescence.

Pappognathia peruana Quintero and Cambra, n. sp.
(Fig. 2, 7, 8)

Pappognathia sp.: Quintero and Cambra (1996: 339)

Male.—Similar to *Pappognathia panamensis* but differing by: clypeus broadly nasutiform, anterior margin convex and with minute, shallow, V-shaped emargination medially (Fig. 2); mandible (Fig. 7) at base with reduced laminar ventral process; vertex with dense pale pubescence, except area around ocelli with black pubescence; dorsoanterior area of propodeum covered with dense pale pubescence, sculpture not visible; T3 and T4 covered with pale pubescence, except small medial area with black pubescence; tibial spurs of middle and hind tibiae pale. Length: 12 mm.

Holotype: male.—**PERU:** Madre de Dios Departamento, Reserva Manu, Estacion Pakitza, 9 Mar 1992, D. Quintero (MIUP). Paratype: same data as holotype but 26 Feb 1992, R. Cambra, 1 ♂ (MIUP).

Diagnosis.—*Pappognathia peruana* differs from the other species of the genus in having a shallow V-shaped emargination on the anterior margin of the clypeus, and by the reduced basal ventral laminar process on the mandible.

Comments.—The holotype was collected resting on a leaf of a shrub about 1m above the ground inside the forest, at about 1600 hours. The paratype, collected

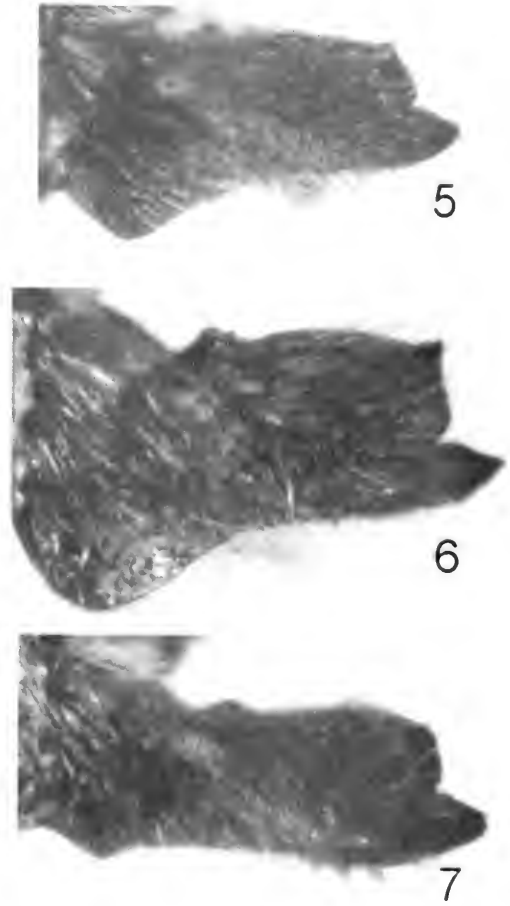
with an insect net, was flying about 3m above the muddy soil of a narrow forest trail, at noon. This is probably the male of either *P. speciosa* Mickel or *P. limes* Mickel. One female of the former was collected in Estacion Pakitza (Quintero and Cambra 1996). The latter species is known from similar habitats in Peru and Ecuador, and might be a junior synonym of *P. rotifera* (Gerstaecker, 1874), from Colombia. Thus, at present it is best to treat these males as a new species until additional evidence is available.

Pappognatha myrmiciformis
(Cameron, 1897)
(Figs. 3, 5, 9, 10, 15)

Male.—Similar to *P. panamensis* but the clypeus has a deep, rounded emargination medially, the depth of which is one third the length of the clypeus (Fig. 3), and the penis valve in a lateral view (Fig. 15) has a sharp angulation in its anterior margin near the base of the apical tooth. Length: 10–10.5 mm.

Material examined.—The specimen from Honduras represents a new country record and the northernmost record for this Neotropical genus.

HONDURAS: Atlantida, Lancetilla, Tela, 15 May 1995, R. Cave, 1♀ (MIUP). **COSTA RICA, Limon** Province: Sector Cerro Cocori, Finca de E. Rojas, 150m, 26 Mar – 24 Apr 1992, F. Quesada, 1♀ (INBio); Cerro Tortuguero, 1–120m, Jul 1993, R. Delgado, 1♀ (MIUP). **Heredia** Province: Estacion El Ceibo, Parque Nacional Braulio Carrillo, 400–600m, Nov. 1989, R. Aguilar, 1♀ (INBio); Feb 1990, C. Chaves, 1♂ (MIUP); Estacion Magsasay, Parque Nacional Braulio Carrillo, 200m, Mar 1991, A. Fernandez, 1♀ (INBio). **Guanacaste** Province: Estacion Pitilla, 700m, 9 km S Sta. Cecilia, Nov 1988, 1♀ (INBio); same data, Mar 1995, P. Ríos, C. Moraga (Malaise), 1♀ (INBio); same data, May 1989, I. Gauld, 1♀ (INBio); Estacion Maritza, 600m, lado O. volcan Orosi, Feb.1992, F. Araya, 1♀, 1♂ (INBio). **Puntarenas** Province: Golfito, Reserva Forestal Golfo Dulce, Estacion Agujas, 250–350m, 17 Mar 2000, A. Azofeifa, 1♀ (INBio); Golfo Dulce, 24 km Piedras Blancas, 2 Jun–Aug 1989, P. Hanson, 1♀ (British Museum of Natural History). **Alajuela** Province: San Cristobal, 600–620m, 15–28 Mar 1998, F. Quesada, 1♀ (INBio). **Guanacaste** Province: sotobosque, W. side volcan Cacao, 1100m, Feb 1989, I.



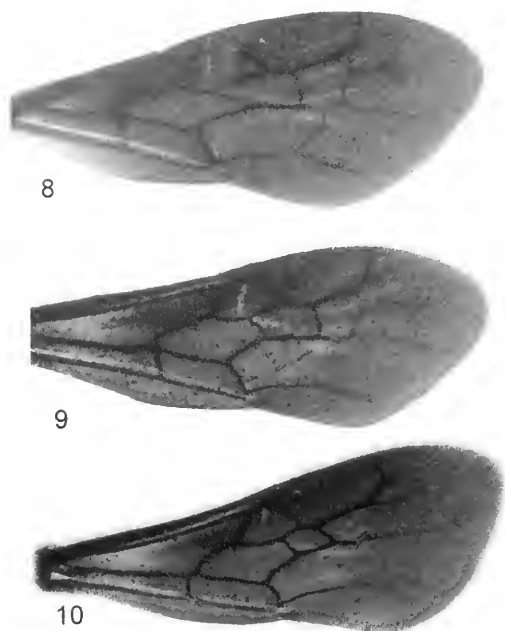
Figs. 5–7. *Pappognatha*, male mandibles. 5, *myrmiciformis*. 6, *patruelis*. 7, *peruana*.

Gauld, 1♀ (MIUP). **PANAMA, Coclé** Province: Penonome, cabecera Rio Riecito with Quebrada Platanal [8° 52' 44", 80° 16' 38"], 110msnm, 22 Jun 2001, C. Vega, 1♀ (MIUP). **Darien** Province: Parque Nacional Darien, Estacion Rancho Frio, Pirre, 80m, 30 Jul – 8 Aug 2002, A. Santos, R. Miranda, 1♀ (MIUP). Other females from Panama were examined by Cambra and Quintero (1992), and Yanega (1994).

Distribution.—Honduras, Costa Rica and Panama.

Comments on sex association.—Extensive samples show the presence of only one species of *Pappognatha* in Costa Rica, and the capture of male and female at the same place and time support the association.

Comments.—The male specimen from Guanacaste, Est. Maritza, Feb.1992, has an



Figs. 8–10. *Pappognatha*, right wings. 8, *peruana*. 9–10, *myrmiciformis*.

aberrantly shaped second submarginal cell (SM2) on the right wing (Fig. 10). The left wing on the same specimen and the wings of the other male specimen of *P. myrmiciformis* examined (Fig. 9) have typical pentagonal SM2, as do all other male *Pappognatha*.

Pappognatha patruelis (André, 1898)
(Figs. 4, 6)

Male.—Integument black. **Head:** very large, quadrate, slightly broader than long; gena, frons, clypeus and mandible with pale setae; vertex with black setae; anterior margin of clypeus broadly nasutiform, with median U-shaped emargination (Fig. 4); mandible at base with broad, rounded, laminar ventral process; flagellomere I 1.5X as long as flagellomere II; frons and vertex with medium-sized punctures, most spaces between punctures usually less than their diameters; vertex small, distance between inner eye and lateral ocellus approximately equal to diameter of the latter. **Meso-**

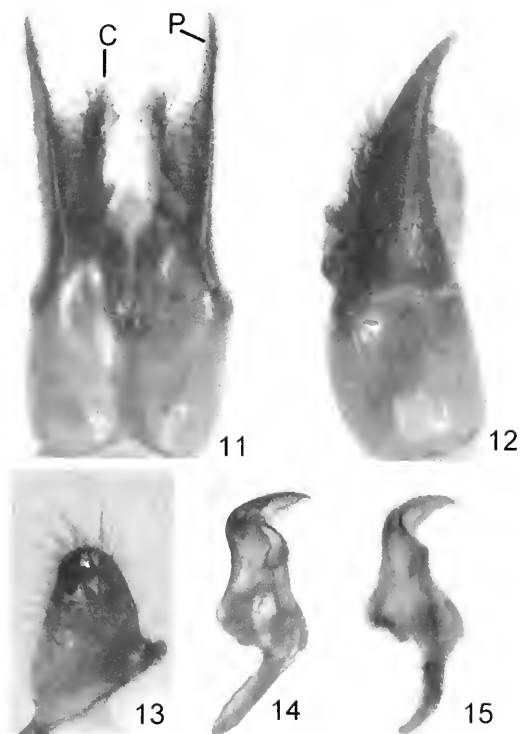
soma: with pale setae, except pronotum, mesonotum, tegula and anterior half of scutellum with black setae; pronotum, mesonotum and scutellum with dense, closely-spaced punctures; propleuron with scattered, small punctures; dorsal and ventral areas of mesopleuron convex, separated by deep groove, elevated areas with medium-sized punctures, anterior and posterior areas practically impunctate; metapleuron impunctate; propodeum reticulate; scutellum convex. **Legs:** with pale setae; apical tarsomeres segment produced into short lamellate plate covering the claw bases; tibial spurs of mid- and hind legs pale. **Metasoma:** with pale setae on: dorsal face of T1, lateral margin of T2, very small lateral area of T3 and T4, all sterna except S7; black pubescence on: remainder of T2, other terga, and S7; anterior face of T1 glabrous, impunctate, with conspicuous medial tooth on each lateral margin; T2 with medium-sized punctures laterally, somewhat smaller along posterior margin, disk glabrous and with punctures scattered; T3 to T6 and S3 to S6 with dense, small punctures interspersed; S2 gibbose anteriorly at the middle, with sparse small punctures. Parameres broad at base, narrowing toward apex, triangular in lateral view, with dense large setae on basal two-thirds of ventral margin. Length: 11.8 mm.

Diagnosis.—*P. patruelis* closely resembles *P. panamensis* and *P. myrmiciformis* but differs by: the shape of clypeus (Fig. 4); rounded basal laminar process on mandible (Fig. 6); frons and vertex with dense punctures, most spaces between punctures usually less than their diameter; pale calcaria of mid- and hind tibia.

Material examined.—**BRAZIL:** Bahia: Ilheus, Jan 1994, J. Franco, 1♀ (MIUP). Minas Gerais: Caratinga, Fazenda Montes Claros [19° 45' S, 41° 50' W], 30–31 Dec 1994, G. Melo, "Nascida de ninho de *Euglossa* sp. dentro de orifício em tronco no chão em decomposição", 2♀, 1♂ (MIUP).

Distribution.—Brazil.

Comments on sex association.—Two fe-



Figs. 11–15. *Pappognatha*, male genitalia. 11–14. *P. panamensis*: 11–12: parameres: 11, dorsal view; 12, lateral view; 13, volsella, lateral view; 14, penis valve, lateral view. 15. *P. myrmiciformis*, penis valve, lateral view. Abbreviations: C, cuspis; P, paramere.

males and one male were reared from three cells of one nest of *Euglossa* sp. The females fit the description of *P. patruelis* (André) given by Mickel (1939) who examined eight females, from Bahia (including the holotype and a paratype), São Paulo and Espírito Santo, Brazil. The male of *P. patruelis* is here described for the first time, based on a single male that died at the teneral stage; its wings were not extended and the mesosternum was not sclerotized and was deformed (concave).

Pappognatha speciosa Mickel, 1939
(Fig. 16)

Material examined.—The specimens from Colombia and Ecuador represent new country records.

COLOMBIA: Amazonas, P.N. Amacayacu, 290m,

30 Feb 1988, 1 ♀ (AMNH). **ECUADOR:** Oriente, Limoncocha (00°24'S, 76°36'W), 21 Jul 1970, C. W. Rettenmeyer, 1 ♀ (Brothers pers. col.). **PERU:** 3 ♀, Quintero and Cambra (1996).

Distribution.—Colombia, Ecuador and Peru.

Comments.—The female from Ecuador has the integumental spots darkish yellow, and the pale pubescence on T3–5 not interrupted with black (Brothers, pers. comm.); the type specimen has integumental spots ferruginous and pale pubescence on T3–5 narrowly interrupted medially with black. Mickel (1939) mentioned that *P. speciosa* is similar to *P. egregia*, but differs only in the size of the integumental spots of T2 (larger in *egregia*), and in the outer margin of the spots having pale tomentose pubescence (glabrous in *egregia*). In specimens of *P. myrmiciformis* and *P. patruelis* that we have examined, as well as in many other species in different mutillid genera (e.g., *Pseudomethoca* and *Hoplomutilla*), the integumental spots on T2 are quite variable in size. Thus, we consider the size of the integumental spots on T2 to be an unreliable character for species identification. Thus, *egregia* and *speciosa* might represent but a single species. In addition, *Pappognatha torquata* Mickel, 1939, might be conspecific with *P. speciosa* but *P. torquata* is known only from the holotype from Bolivia (no additional label data). According to Mickel (1939), they differ in having the pronotum pubescence entirely pale tomentose in *P. torquata* and the pronotum clothed with sparse, black setae in *P. speciosa*, and the dense pale pubescence on the vertex extending anteriorly along the inner margin of the eye in *P. torquata*, but not in *P. speciosa*.

Pappognatha egregia Mickel, 1939

Material examined.—The specimens from Colombia and Ecuador represent new country records.

COLOMBIA: Amazonas, Puerto Santander, 160m, 7 Sep 1991, 1 ♀ (AMNH); Meta, Villavicencio, 25 Jul 1938, 1 ♀ (MIUP); Putumayo, Santa Rosa, Rio San Mi-



Figs. 16–17. *Pappognatha* females, habitus. 16. *P. panamensis*. 17. *P. speciosa*.

guel, 1–30 Oct 1970, Malkin, 1♀ (MIUP). **ECUADOR:** Napo: Cuyabeno, Apr 1986, 1♀ (MIUP); Cuyabeno, Aug 1983, 400m, 1♀ (MIUP); El Reventador, May 1986, 1♀ (MIUP); Limoncocha, 24 Jun 1975, 1♀ (MIUP). **BRAZIL:** Amazonas: 60 km N. Manaus, 16 Aug 1991, G. Melo, 1♀ (MIUP); 1905, 1♀ (AMNH); Manaus, Reserva Ducke, 3 May 1968, 1♀ (MIUP).

Distribution.—Colombia, Ecuador, Brazil.

Pappognatha limes Mickel, 1939

Material examined.—**ECUADOR:** Pastaza, Cusuimi, Rio Cusuimi, 150 km SE of Puyo, 15–31 May 1971, B. Malkin, 1♀ (MIUP); Pastaza, Mera, Apr 2002, 1♀ (MIUP). **PERU:** Monson Valley, Tingo Maria, 11 Dec 1954, 1♀ (AMNH).

Distribution.—Ecuador and Peru.

Comments.—A female from Colombia (along margins of Rio Calima, Restrepo, Valle, 11 Feb 1984, MIUP) differs from the original description in having the pale pubescence on T3–T5, interrupted medially. The frons is covered with pale

pubescence, as in typical *P. rotifera* (Gerstaecker, 1874). We have identified this specimen as *P. rotifera*, and conclude that *P. limes* is probably a junior synonym of *P. rotifera*, a species previously known from only two specimens from Colombia, the holotype from Bogota and a second specimen from Muzo, Boyaca (Mickel 1939).

Pappognatha obliqua Mickel, 1939

Material examined.—The specimens represent a new country record.

PERU: Nauta, Amazonas, Carrasco col., 2♂ (AMNH, MIUP).

Distribution.—Peru and Brazil.

Comments.—The two additional males from Peru fit Mickel's description of *P. obliqua*. This might be the male of *P. pertyi* (Dalla Torre) (Mickel 1939), a species known from Para, Brazil.

ACKNOWLEDGEMENTS

We thank the following curators and their institutions for loan or donation of specimens used in this study: James M. Carpenter (AMNH), Gabriel Melo (Universidade Federal do Parana), Paul Hanson (University of Costa Rica), Daniel Curoe (Palo Alto, California, USA), Jesus Ugalde and Alvaro Herrera (IN-Bio) for loan of specimens from the Project Biodiversity Resources Developments under the auspices of the World Bank and Global Environmental Facility (GEF). Our field work in Darien National Park, Panama, was supported in part by funds from BIODAR-IEN-ANAM and fund No.04-05-94-01 from the Universidad de Panama; field work in Manu Reserve, Peru, was supported by funds of the Biological Diversity in Latin America Project (BIOLAT), Smithsonian Institution. We thank Denis J. Brothers, University of KwaZulu-Natal, South Africa, for the meticulous review, for providing additional specimen data and the photograph of *P. speciosa*. Our thanks to Annette Aiello, Smithsonian Tropical Research Institute, and Wojciech J. Pulawski, California Academy of Sciences, for their thoughtful and critical reviews, and the suggestions made to improve the manuscript.

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Redescription of *Pelicope yuccamica* Mason (Hymenoptera: Braconidae: Microgastrinae), With Notes on its Unusual Biology and Relationships

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Abstract.—A more complete illustrated redescription of the monotypic genus *Pelicope* (type species *P. yuccamica* Mason) is provided to assist in phylogenetic placement of this rare and unusual genus. Misinterpretations of its biology are corrected based on host data published after the original description—this species appears not to be associated with *Yucca* as previously reported, but instead only with the incurvariid moth *Mesepiola specca* Davis, a seed-feeder on *Nolina parryi* Watson (Ruscaceae).

The monotypic genus *Pelicope* was erected by Mason in his reclassification of the world genera of Microgastrinae (Mason 1981). He included only the new species *P. yuccamica* Mason, a highly distinctive, polished, xanthic species reported as having only been collected in a restricted region of southern California at *Yucca* flowers. Mason characterized the genus as having a rare combination of morphological traits within the subfamily Microgastrinae—the almost totally xanthic body coloration, the absence of the hind wing vein 2r-m, and the resemblance of the fore wing areolet (Fig. 7) to the fossil genus *Eocardiophiles* described from Baltic Amber by Brues (1933), make this genus very peculiar and (in Mason's view) difficult to classify as closely related to any other genus.

Mason's (1981) description was based on six specimens, all taken from the same locality and month in Riverside County (Upper Deep Canyon at Horsethief Creek in early June), but collected over a 26 year period. In addition to a verbal description, he provided simple but accurate line drawings of the head, wings, anterior mesergites and female ovipositor

mechanism. Interestingly, he omitted in the description a number of observable features that might have helped place the genus in his new classification. Although the type series contained males, no mention of male genitalic features was made, and a number of other small features relevant to comparative study of microgastrine genera were also not mentioned.

The phylogeny and classification of microgastrine genera has remained controversial and difficult to resolve (e.g. Mason 1981, Austin 1990, Walker et al. 1990, Maetô 1996, Whitfield et al. 2002), in part due to the lack of data for a number of genera. In this context, a more complete description of *Pelicope* has been of interest for some time. Further, a number of other aspects of *P. yuccamica* have now come to light, some of them scattered enough in the literature and collections that it has only recently become possible to integrate them into a fuller picture of this remarkable species.

Biology.—Force (1989), in a study of the biology of the incurvariid moth *Mesepiola specca* Davis, whose larvae feed on the seeds of *Nolina parryi* (previously in Agavaceae, now reclassified in the Rusca-



Figs. 1–2. 1, Lateral habitus photo of *Pelicope yuccanica* Mason, female, reared from *Mesepiola specca*. 2, close-up of ovipositor and sheaths.

ceae—butterfly's broom family—Judd et al. 2002), reared a series of *P. yuccanica*, from which we have been able to examine specimens. Since extensive studies of yucca/yucca moth biology and coevolution (reviewed in Pellmyr 2003) have apparently never yielded *Pelicope* (O. Pellmyr, personal communication), it seems clear now that the earlier records of *Pelicope* as being associated with *Yucca* were based on misidentifications of *Nolina* as *Yucca*, which it does indeed superficially resemble, although the two are now in different plant families.

Force (1989) discussed an interesting problem for specialist parasitoids attack-

ing *M. specca*. *Nolina parryi* does not flower (and thus does not produce seeds) every year, but does so irregularly and synchronously in local areas. *Mesepiola* appears to be able to synchronize with *Nolina* somehow (although it also has two other less common recorded hosts which might occasionally fill in). Either *Pelicope* has other local hosts besides *M. specca* (or can find the occasional *M. specca* on its other host plants), or it too has found some way to synchronize its emergence with the flowering years of *Nolina*. Perhaps the latter strategy might explain why so few *Pelicope* have ever been collected in an area rich in entomologists.

Force (1989) also states that *Pelicope* are likely to be ovipositing into host eggs, although he does not discount that they could be finding very early instar larvae. Oviposition into eggs does not appear to be common in Microgastrinae, but is known to occur in some *Cotesia* and *Diolcogaster* species (Ruberson and Whitfield, 1986). Since Force's observations were indirect in the sense that he drew conclusions based on the timing of host oviposition and *Pelicope* adult activity rather than on direct *Pelicope* ovipositions, at this point the question must remain open.

More recent studies of *Pelicope* morphology.—Maetô (1996), in a comparative study of male genitalia (especially of volsellar structures) in Microgastrinae, partially described the male genitalia of *Pelicope* and presented a photo of a slide mounted genital capsule focusing on the digitus and cuspis structure. There were not enough characters in his study to confidently place the genus phylogenetically, but it did have a unique combination of the five characters polarized by Maetô in his discussion.

Whitfield et al. (2002) attempted to synthesize the available comparative morphological data for microgastrine genera (including some of Maetô's data and attempting to include the features considered by Mason) and analyzed these data alone and in combination with DNA se-

quence data from three gene fragments. Specimens of *Pelicope* suitable for molecular study were unavailable at that time, but several morphological characters were coded from the type series for the genus that were neither mentioned by Mason (1981) nor observable from his illustrations. The preliminary phylogenies based on both morphological and combined data appeared to confirm Mason's speculation that *Pelicope* represents an isolated, relatively basal lineage, but support for this position is still poor.

Below we provide a morphological re-description of *P. yuccanica*, expanding upon the description of Mason (1981) and the character codings of Whitfield et al. (2002) and providing a series of digital photographs and environmental scanning electron micrographs of a female specimen from Force's (1989) material. It is hoped that these additional data will improve the interpretation of the morphology of *Pelicope* for future phylogenetic work. In addition, we hope our clarification of the biology of *Pelicope* will stimulate further field studies of this unusual animal.

MATERIALS AND METHODS

The principal morphological terminology used in the species description is that of Huber and Sharkey (1993) as well as of Schuh (1989); except for that of the morphology of the propodeum, which is used *sensu* Townes (1969, Fig. E) and Austin and Dangerfield (1992, Fig. 1). The cuticular sculpturing terminology follows that of Harris (1979), while the terminology for the wing venation is a variation of the Comstock-Needham system used by Sharkey and Wharton (1997, Fig. 15).

Digital color photographs were taken using a JVC GC-QX5HD digital still camera mounted on a Leica MZ12/5 stereomicroscope. ESEM photographs were taken using a Philips XL30 ESEM-FEG electron microscope.

Pelicope yuccanica Mason (Figs. 1–9)

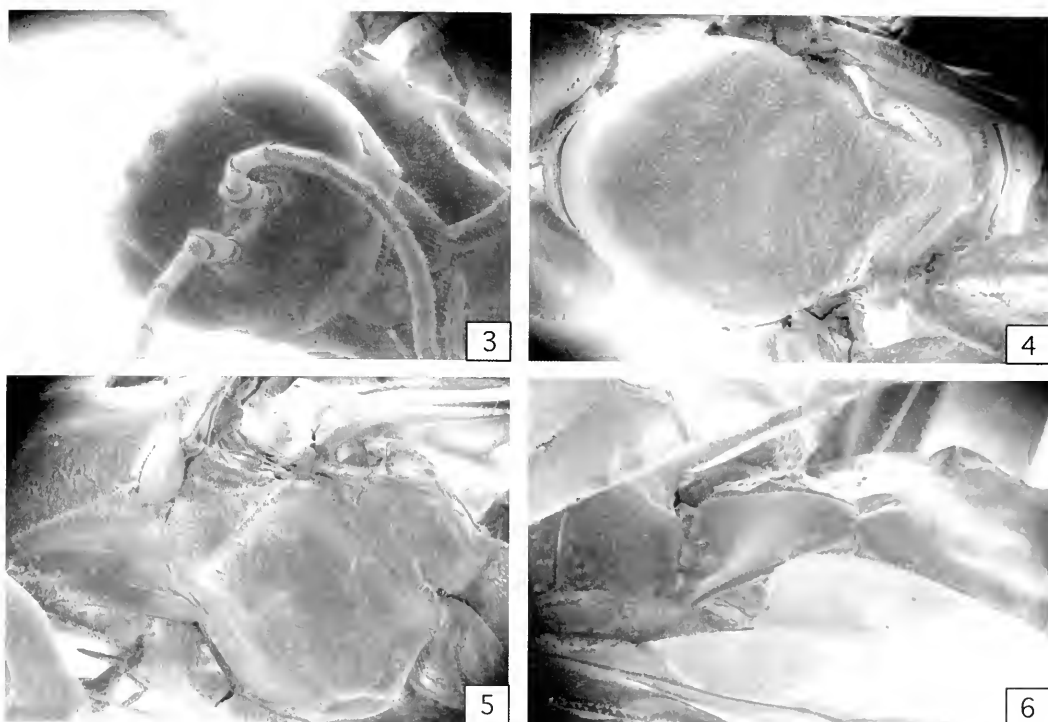
Body color.—Light golden yellowish-brown except for distal 1/5 of hind femur; hind tibia (at least apically) and tarsomeres dark brownish yellow; ovipositor sheaths and antennae beyond scape very dark brown to essentially black; ventral ½ of head anteriorly whitish.

Size.—Body length 3.1–3.5 mm. Forewing length 3.1–3.4 mm.

Head.—Face broad, very weakly sculptured; inner margins of eyes not converging ventrally, sometimes even weakly diverging. Clypeus broad, shallowly semicircular above broad subtriangular labrum which largely conceals mandibles in frontal view. Antennae unusually thin and short for Microgastrinae (Fig. 1); placodes two-ranked on at least proximal 10 flagellomeres, and ventral area same as dorsal for subapical flagellomeres. Glossa truncate. Maxillary and labial palps slender, pale yellowish, relatively short.

Mesosoma.—Pronotal lateral area with two nitid grooves; propleuron lower outer corner simple (Fig. 5). Mesonotum shiny, nearly smooth, without or with very indistinct punctation, but with very smooth, broad, shallow suggestions of notauli and raised medial lobe (Fig. 4). Epicnemial carinae absent; mesopleura weakly sculptured except anterodorsally and near poorly defined sternaulus (Fig. 5). Scutoscutellar groove narrow, convex towards anterior, with very tiny shallow pits (Fig. 4). Scutellar disc subtriangular, very weakly punctate, slightly wider anteriorly than long; lunulae slightly curved dorsally and mainly of uniform width, with nitid medio posterior scutellar band. Metanotum with sub-scutellar hairs absent; anterior margin appressed to scutellum. Propodeum smooth, with more horizontal anterodorsal area greatly shortened and gradually curving to strongly declivous face, without carinae.

Legs.—Fore telotarsus normal in shape



Figs. 3–6. ESEM Photos of *P. yuccamica* female: 3, head, anterior view; 4, mesosoma, dorsal view; 5, mesosoma, lateral view; 6, anterior metasomal tergites, dorsal view.

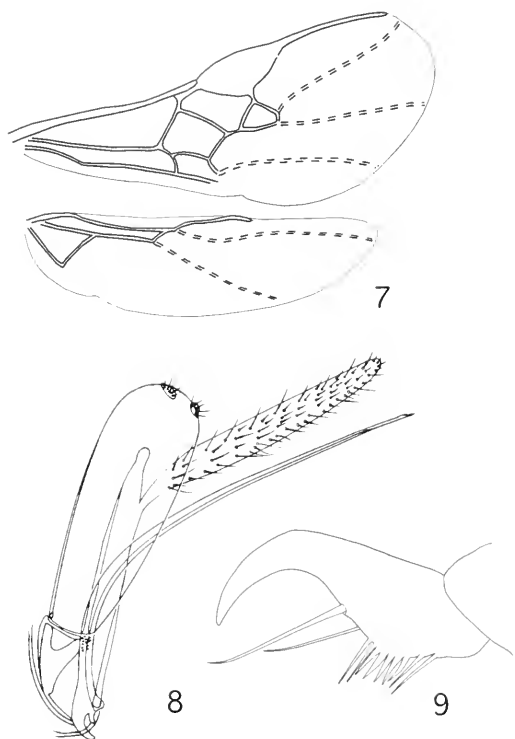
(not excavated apicoventrally). Hind coxae not strongly enlarged (thus resembling non-*Diolcogaster* Microgastrinae); hind tibial spurs subequal in length and about $\frac{1}{3}$ length of hind basitarsi; tarsal claws appearing simple under low magnification but actually bearing a cluster of 4–5 tiny slender teeth basally (Fig. 9).

Wings (Fig. 7).—Forewing vein 3Rs strongly convex towards costal vein, 1M+1Rs straight, r-m meeting 3Rsa to close the unusually large areolet, 2A absent. Stigma pale yellowish basally, otherwise brown; veins mostly yellowish brown. Hindwing veins r, 2A and 2r-m absent, cells 1R and 2R of approximately same width, veins 2Cu and cu-a straight; vannal lobe with a distinct apical notch, convex in shape and with setosity short and sparse beyond broadest point.

Metasoma.—First metasomal tergite with gentle anterior basal excavation rather than mediobasal longitudinal groove (Fig.

6), apical half flat to gently arched and without medioapical excavation, in dorsal view narrowing towards apex of tergum. Second metasomal tergite subtriangular and relatively small, appearing undefined posteriorly due to exceptionally weak posterior groove. Third metasomal tergum 1.5× as long as second tergite. General aspect of metasoma not carapacelike and with terga nitid. Medial longitudinal area of hypopygium desclerotized and with longitudinal pleats. Ovipositor mechanism (Fig. 8) with eighth tergite 3× taller (dorsoventrally) than long and with the apodeme shorter than wide; second valvifer tall and lorate; the slender straight ovipositor sheaths (Figs. 2, 8) arising from second valvifer near apex, setosity present through length; ovipositor in lateral view very weakly decurved and evenly tapered throughout its length.

Male genitalia (from Maetô, 1996—his Table 1 and Fig. 10).—Lamina volsellaris



Figs. 7–9. *P. yuccamica*, female: 7, wings; 8, ovipositor mechanism, lateral view; 9, hind tarsal claw. 7, 8 after Mason (1981); used with permission.

0.28 mm long, with 2 setae. Digitus $0.57\times$ as long as lamina volsellaris, slender basally and apically acute and directly dorsally, but with ventral edge slightly convex; apex with 3–4 apical teeth.

Larva and cocoons.—Force (1989) states that *Pelicope* spend the winter in the soil in the host larvae and adults emerge the following late May/early June when the adult *Mesepiola* are ovipositing into developing seeds. Since the host spins a tough cocoon in the soil, probably the parasitoid cocoon is inconspicuous within it.

Material examined.—Holotype: USA, California, Riverside Co., Upper Deep Canyon at Horsethief Creek, 1000 m, 11/vi/1965, Col. E. Schlinger. Paratypes (2 ♀♀ and 3 ♂♂) and holotype in the U. S. National Museum. Additional specimen used for re-description and figures: USA: California: Riverside Co.: Pison Flat, 18/vi/1987, D. Force, ex. *Mesepiola* sp. and *N. dina parryi* (in Illinois Natural History

ACKNOWLEDGMENTS

We would like to thank Drs. Henri Goulet (Canadian National Collection, Ottawa) and David Smith (U. S. National Museum, Washington) for the opportunity to examine *Pelicope* specimens in their care. Olle Pellmyr provided invaluable help on the question of whether *Pelicope* is associated with Yucca moths, and helped locate the Force paper. Scott Robinson of the Imaging Technology Group, Beckman Institute, University of Illinois, provided assistance with the ESEM photography. This work was supported in part by National Science Foundation grant DEB 0235784 and U. S. Department of Agriculture NRI grant 2003-35316-13679 to JBW.

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NOTE

Ormyrus salmanticus Nieves-Aldrey, 1984 (Hymenoptera: Chalcidoidea: Ormyridae), a Valid Species

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Ormyrus salmanticus Nieves-Aldrey was described in 1984 from Casillas de Flores, Salamanca (Spain), reared from galls of *Aulacidea subterminalis* Niblett, 1946, a herb gall wasp (Hymenoptera, Cynipidae, Aylacini) that induces semi-subterranean galls in runners of *Hieracium pilosella* L. (Asteraceae). This species is easily distinguished from other Iberian ormyrid species by several important diagnostic characters, as follows: second metasomal tergite smooth dorsally and with weak crenulate sculpture of tergites 3–7, lacking the typical rows of deep foveae of many Ormyridae; head only slightly broader than high in anterior and posterior views; postmarginal vein relatively long, 1.6 times as long as stigmal vein; metatibia as long as metatarsus.

Narendran (1999) published a systematic monograph on the Indo-Australian Ormyridae and stated that *O. salmanticus* is a junior synonym of *Ormyrus langlandi* Girault, 1920, a decision that has been subsequently accepted by other authors (Noyes 2002). Narendran did not examine the type material of *O. salmanticus* that is available at the Museo Nacional de Ciencias Naturales in Madrid. However, the author said that “from the description and figures of *Ormyrus salmanticus* Aldrey (Aldrey, 1984) (*sic*), described from Spain, it is evident that it is a new junior synonym of *Ormyrus langlandi* Girault”.

While its superficial resemblance, on

the basis of the original description and figures of *O. salmanticus*, there are however many morphological features of this species that do not fit the description given by Narendran of *Ormyrus langlandi*. The specific biology of *O. salmanticus* and its more restricted geographical distribution compared with *O. langlandi* (the former recorded only from Spain, although probably much widely distributed in Europe, and the host gall and plant distribution do not overlap the range of *O. langlandi*), were also additional data that cast doubts on the validity of this synonymization. To demonstrate it, we borrowed 16 specimens of *O. langlandi* housed at the NHM of London and compared them with *O. salmanticus*.

Examined specimens came from Zimbabwe (former Rhodesia) labelled as *O. decaryi* Risbec, 1955, a species synonymized with *O. langlandi* by Bouček (1988). We tried to examine first Girault's *O. langlandi* material from the QLD museum but unfortunately we did not receive any replies to our letters.

Comparison of series of specimens of the two supposedly conspecific species showed important morphological differences between them and thus clearly indicated their separate specific status.

Considering the evidence provided above we propose the re-establishment of *O. salmanticus* Nieves-Aldrey as a valid species, *stat. res.*

Table 1. Major morphological differences between *O. langlandi* and *O. salmanticus*.

Diagnostic characters	<i>O. salmanticus</i> 1 male, 3 females examined	<i>O. langlandi</i> 6 males, 10 females examined
Female antenna	Two anelli but the second anellus bears a single placodeal sensilla and is 1.3 times as long as wide; flagellar segments 2 to 5 clearly transverse, about 1.4 times as wide as long. Placodeal sensillae of flagellar segments arranged in a single row.	Two anelli; second anellus transverse, about 2 times as wide as long; flagellar segments 2 to 5 clearly longer than wide, about 1.3 times as long as wide. Placodeal sensillae of flagellar segments arranged in two rows.
Male antenna	Flagellar segments transverse. Placodeal sensillae arranged in a single row.	Flagellar segments longer than wide. Placodeal sensillae smaller, arranged in four or five rows.
Forewing	Postmarginal vein relatively longer; marginal vein 1.2 times as long as postmarginal; postmarginal vein 3.2 times as long as stigmal vein.	Postmarginal vein relatively much shorter; marginal vein 3.5 times as long as postmarginal; postmarginal vein 1.6 times as long as stigmal vein.
Metasoma	Sculpture on dorsal part of second metasomal tergite of female absent; tergite completely smooth.	Dorsal part of second metasomal tergite of female with strong reticulate sculpture.
Biology and distribution	A parasitoid of <i>Anlacidea subterminalis</i> Niblett that induces galls in runners of <i>Hieracium pilosella</i> L. Recorded only from Salamanca and Zaragoza (Spain) but probably much more widely distributed following its host gall wasp and plant.	Biology unknown. Recorded from Australia, India, Laos, China, Zimbabwe and Madagascar.

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